ENGINEERING AND
BOILER HOUSE REVIEW

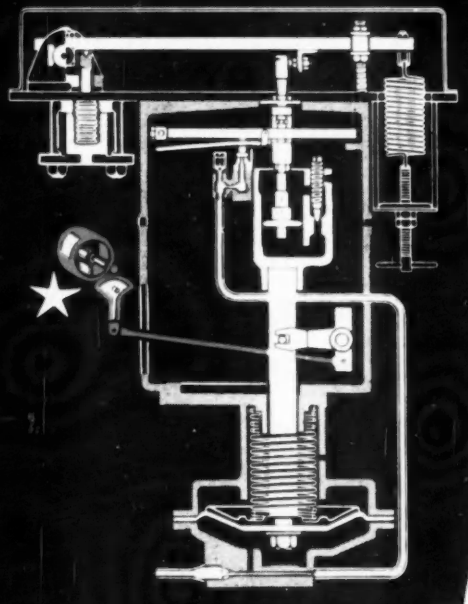
ESTABLISHED 1899

& SIXPENCE

VOL. 73 NO. 12 • THE PIONEER STEAM JOURNAL • DECEMBER, 1958

ELECTROFLO-SMOOT

Electronic **BOILER CONTROL**



Steam generation is a mechanical process. Its successful automatic control requires not only the precise, immediate detection of departures from norms, but *power—precisely applied*—at the final regulating means.

Electroflo - Smoot Control employs pneumatics, hydraulics and electronics solely or in combination—with good sense and unrivalled experience—to suit the specified plant and its operating conditions.

The advanced type electronic system not only eliminates distance transmission lags in high capacity, high energy level steam generators, but—through "steam load" control—it provides the shortest path from the electrical load change to the combustion rate. **Ask for Publication No. S.848.**

★ Electric signal sender to receiving regulator or power unit. System includes integral feedback and bumpless transfer from automatic to manual (constant rating) control.

Electroflo

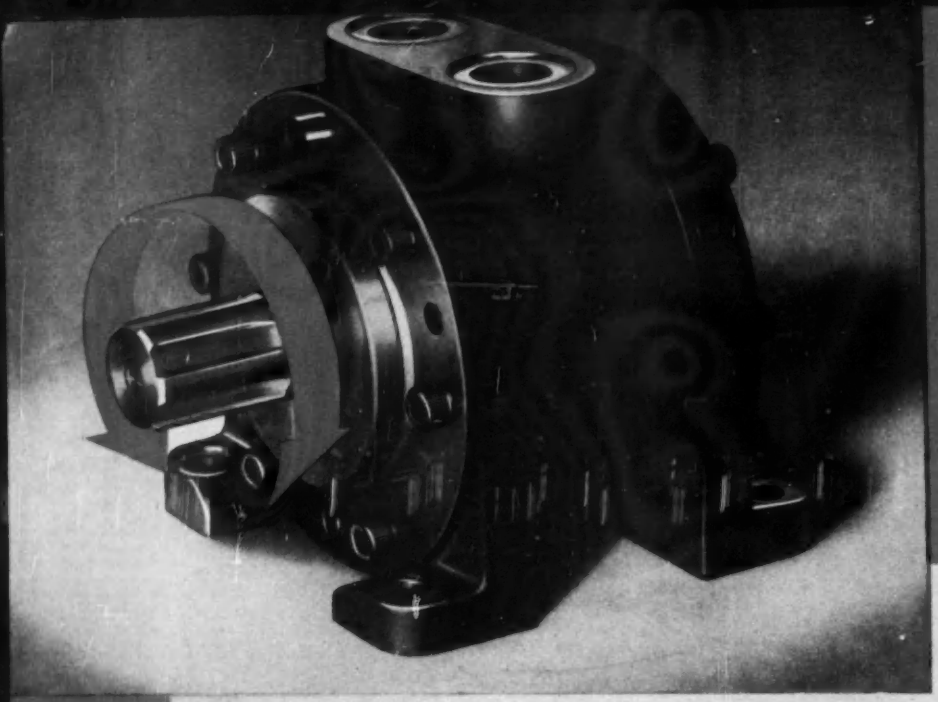
ELECTROFLO METERS COMPANY LIMITED

Head Office: Abbey Road, Park Royal, London, N.W.10.

Factories: Abbey Road, Standard Road & Minerva Works, Chase Estate, Park Royal and Maryport, Cumberland.

Telephone: Elgar 7641.8. *Grams & Cables:* Elflometa, London. Telex: *Telex* No. 2-3196

Member of Elliott-Automation Group



POSITIVE ACTION

EQUAL 2-WAY POWER AT CONTROLLED SPEED

SAVES SPACE

SAVES POWER

SAVES MAINTENANCE

SAVES WEIGHT

EXCLUDES DIRT

HYDRAULIC SLAVE UNIT
with 300° angular motion

This 'semi-rotary' slave is the latest addition to the wide range of LOCKHEED hydraulic units. It is a device which is complementary to the normal straight-acting slave cylinder. Designers are rapidly finding uses to which this unit can be put, in swinging, turning, opening, closing, clamping, oscillating, indexing, pulling, pushing, lifting and lowering.

A range is planned, providing torque outputs from 1,500 to 1,000,000 lb. ins., and up to 300° angular motion in single vane types, and up to 100° in double-vane types.

This unit is available for early delivery in the smaller sizes.

Further details of this and other units in the LOCKHEED range will be sent on request. *Kindly mention this journal.*

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Shaw Road, Speke, Liverpool 24. Telephone: Hunts Cross 2121

Lockheed

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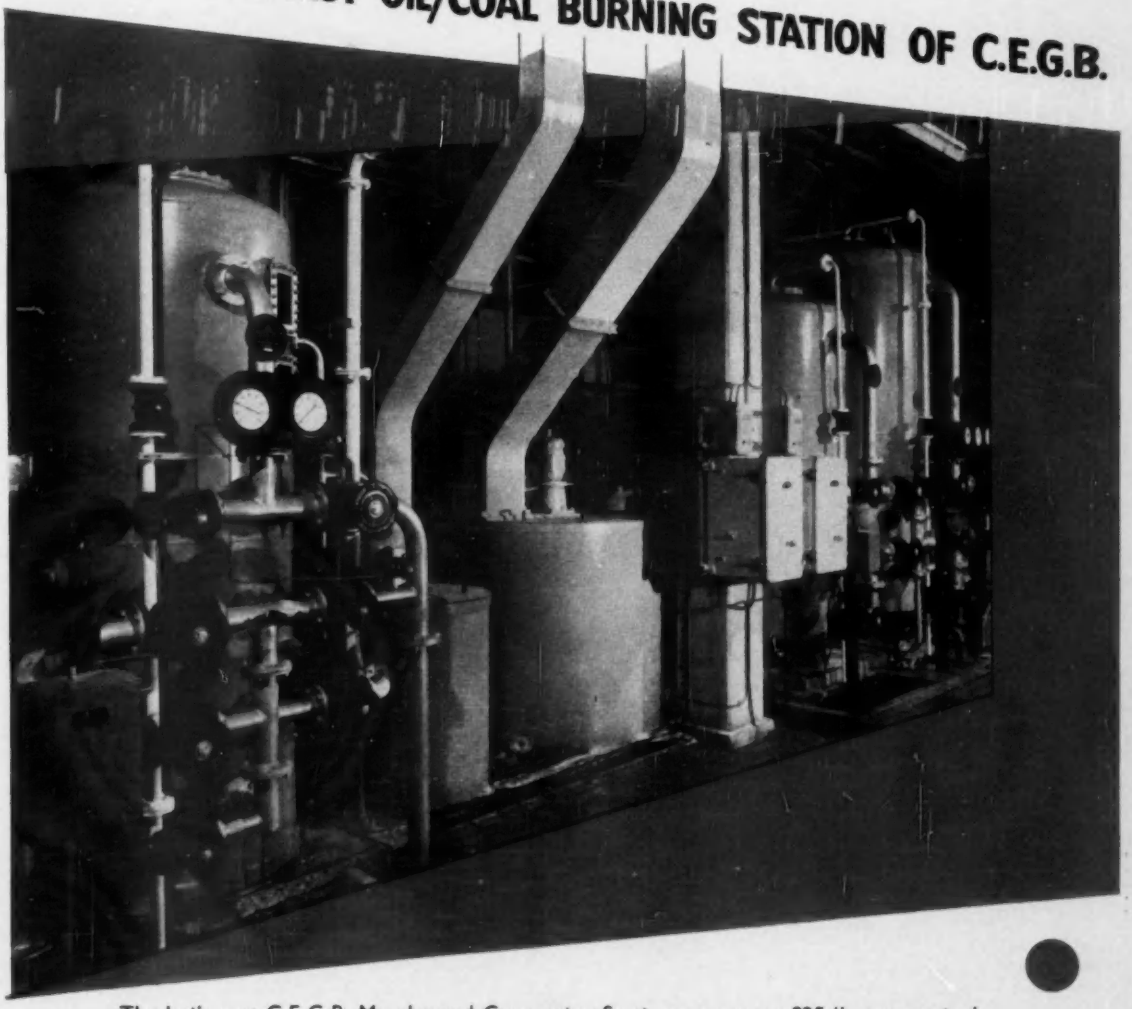
INDUSTRIAL HYDRAULICS

COMPLETE INSTALLATIONS BRITISH MADE **OR INDIVIDUAL UNITS**

PERMUTIT

FOR FIRST OIL/COAL BURNING STATION OF C.E.G.B.



The boilers at C.E.G.B. Marchwood Generating Station operate at 925 lb. per sq. inch, and are provided with "Deminrolit" treated make up feed.

There is no split responsibility with a "Deminrolit" Plant because The Permutit Company design and manufacture the Plant, also develop and manufacture their own Ion Exchange Resins. This is exclusive to Permutit.

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IRON COMPOUNDS & SILICA LESS THAN 1%

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This cement when mixed with appropriate aggregates provides Super-duty Castable Refractory Concrete for service temperatures up to 1,800°C (3,300°F) Refractory Concrete free from Iron Compounds & Silica is now possible for the first time.

A REFRACTORY CONCRETE FOR ANY PURPOSE

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Lafarge Aluminous Cement Co. Ltd.

Manufacturers of

CIMENT FONDU

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ALUMINOUS CEMENT

BECAUSE

Almost the entire Refractory field can be covered by Refractory Concretes based on SECAR 250 or CIMENT FONDU.

SECAR 250 concretes have all the well known properties of Ciment Fondu concretes

PLUS

- **HIGH PURITY**
- **HIGH REFRACTORINESS**
- **HIGH SLAG RESISTANCE**
- **HIGH COLD STRENGTH**
- **HIGH SPALLING RESISTANCE**
- **HIGH CASTING ACCURACY**
- **HIGH RESISTANCE TO CORROSIVE ATMOSPHERES**
- **NO SPECIAL PRE-FIRING PROCEDURE**

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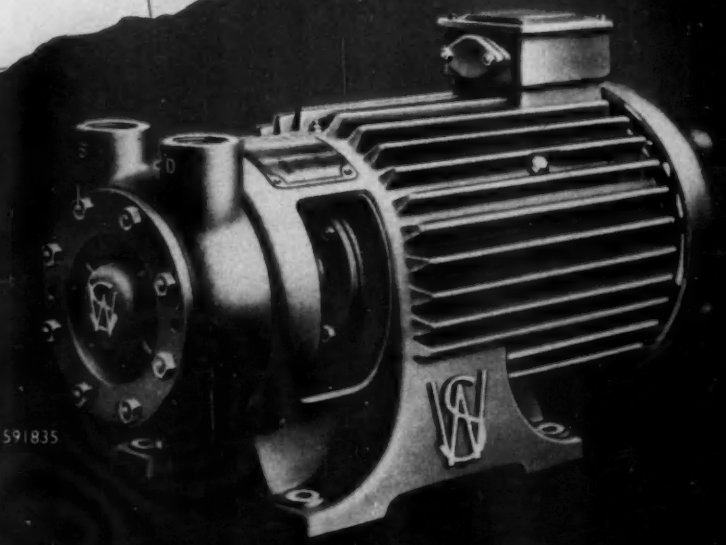
AP/48

Total Head in Feet	
300	PUMP R P M B H P
275	PUMP R P M B H P
250	PUMP R P M B H P

these heads on single stage pumping

A CHEAPER—SIMPLER METHOD OF PUMPING SMALL CAPACITIES AT HIGH HEADS FOR BOILER FEED SERVICE etc.



Patent No. 591835

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RANGE
½ TO 6 B.H.P. UP TO 1770 G.P.H.

for clean low-viscosity liquids

Plus the outstanding advantages of

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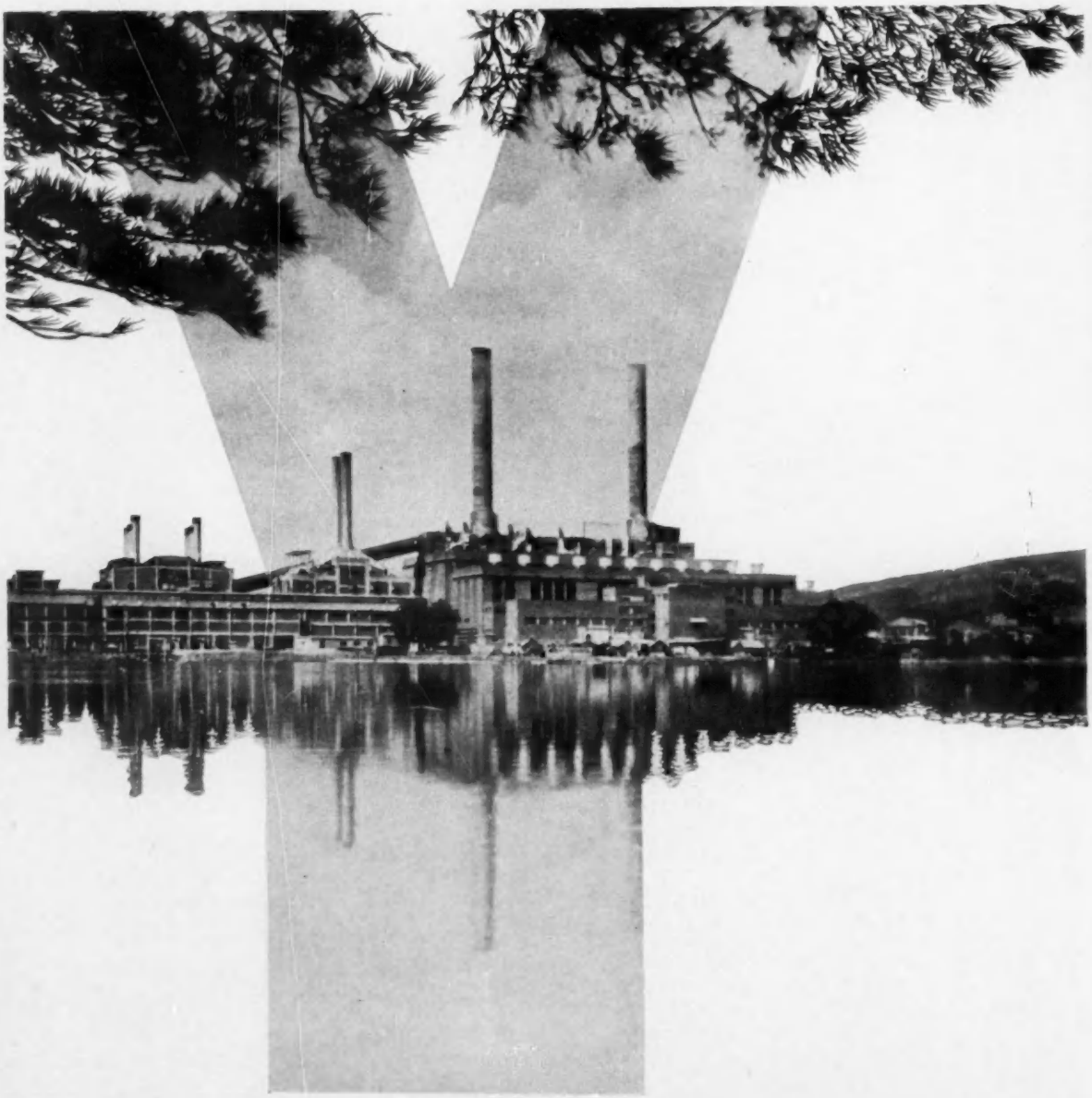

Pretoria 'A' and 'B' Power Stations
City Council of Pretoria South Africa

BOILERS BY **YARROW**

Yarrow & Company Limited
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W.S.E. 22.

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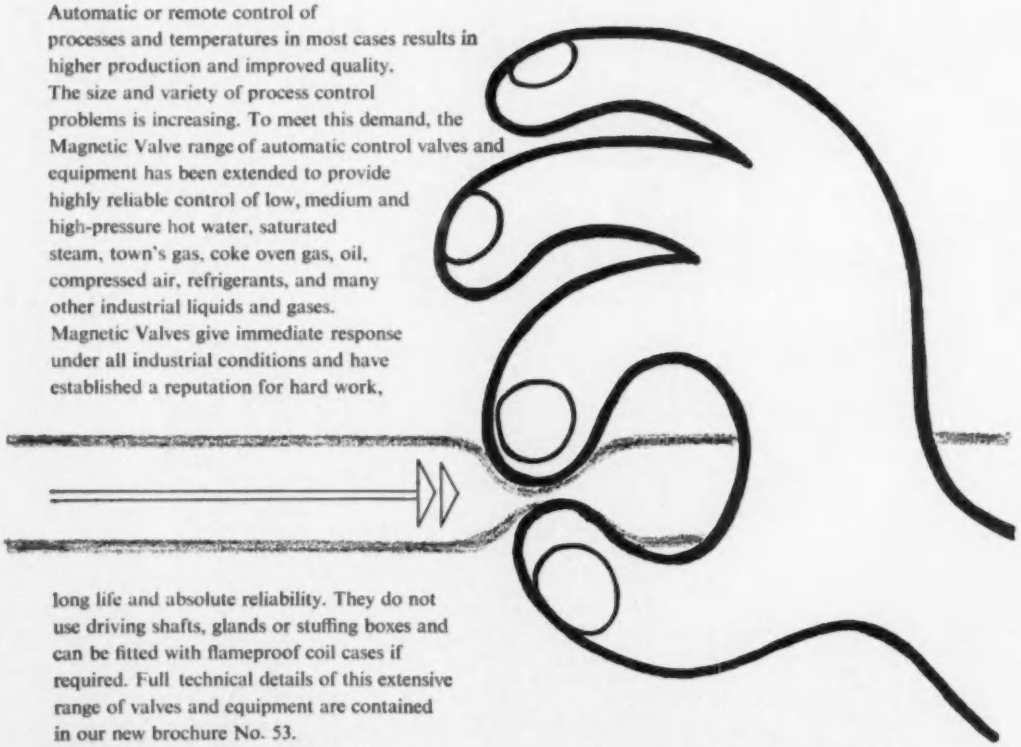

long life and absolute reliability. They do not use driving shafts, glands or stuffing boxes and can be fitted with flameproof coil cases if required. Full technical details of this extensive range of valves and equipment are contained in our new brochure No. 53.
Why not write *NOW* for your copy?

✳ **If you have a problem involving the design, installation and satisfactory operation of automatic control equipment, you'll find our Technical Advisory Service of great benefit.**

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Single-beat Stop Valve with
Flameproof Solenoid Enclosure

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Magnetic 'R' Type
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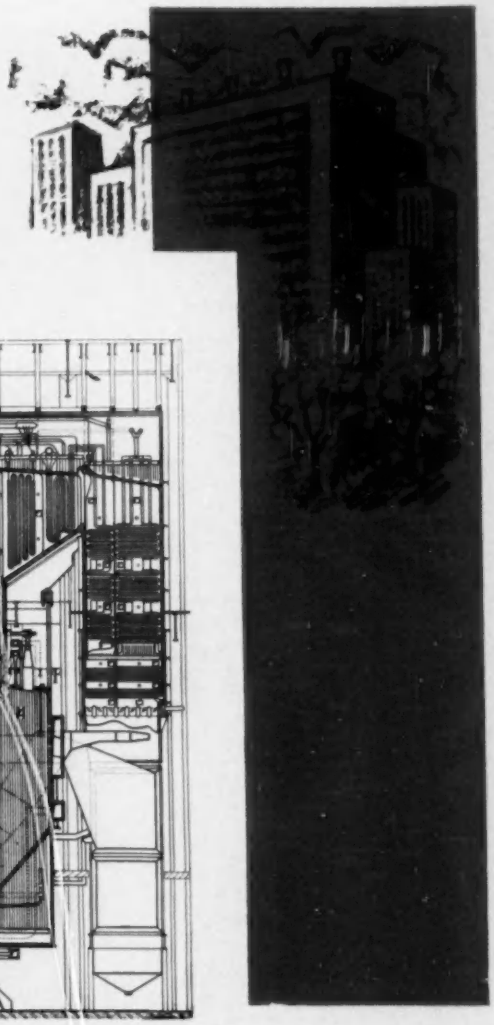

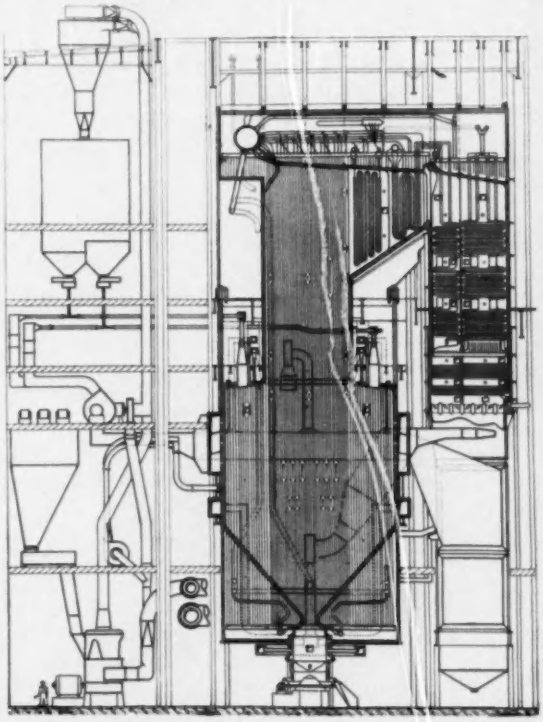

Complete heating systems for power stations for all pressures or temperatures of superheat : Cockerill-Ougrée type for pressures up to 80 kg per sq. cm. or Stein and Roubaix type, applying the processes developed by Combustion Engineering of New York and K. S. G. of Stuttgart for higher pressures.

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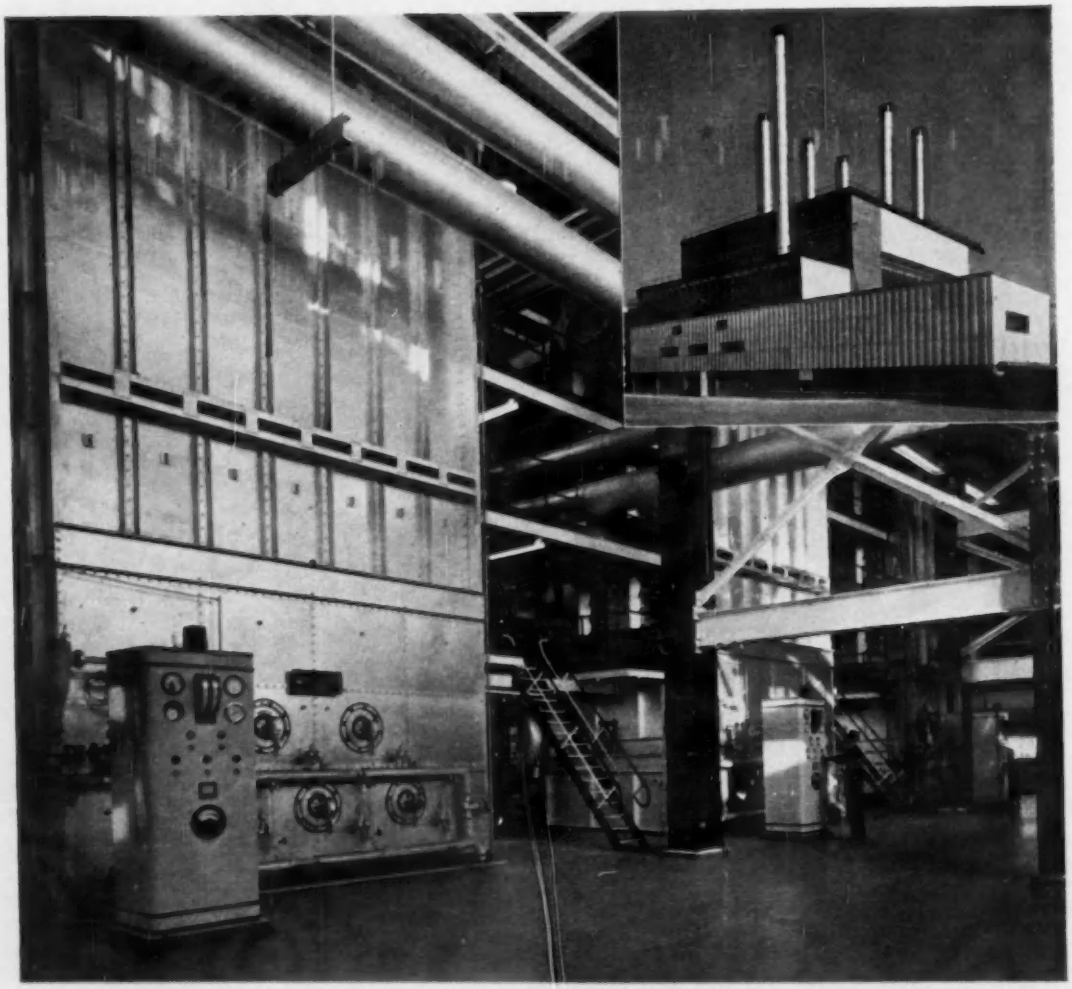
650,000,000 B.T.U's PER HOUR



View on firing floor, with exterior view inset, of the new A.C. Block Boiler House, an integral part of the new extensions at Luton Works

This plant, with 5—70,000,000 B.T.U. High Temperature Hot Water Boilers is the largest of its kind in the world.

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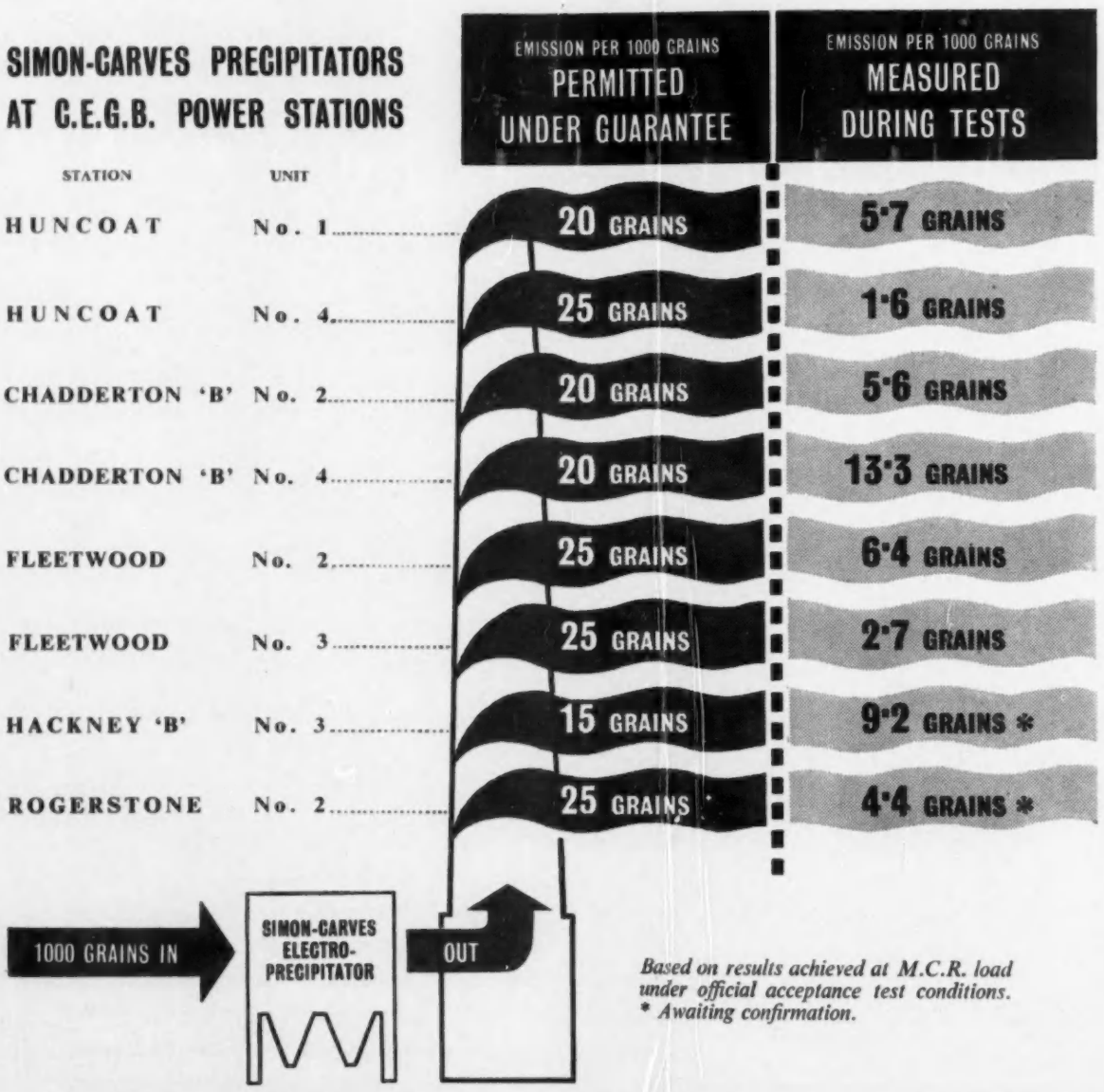
SIMON-CARVES PRECIPITATORS AT C.E.G.B. POWER STATIONS



Based on results achieved at M.C.R. load under official acceptance test conditions.
** Awaiting confirmation.*

HIGH EFFICIENCY ELECTRO-PRECIPITATION BY

Simon-Carves Ltd

SIMON ENGINEERING GROUP

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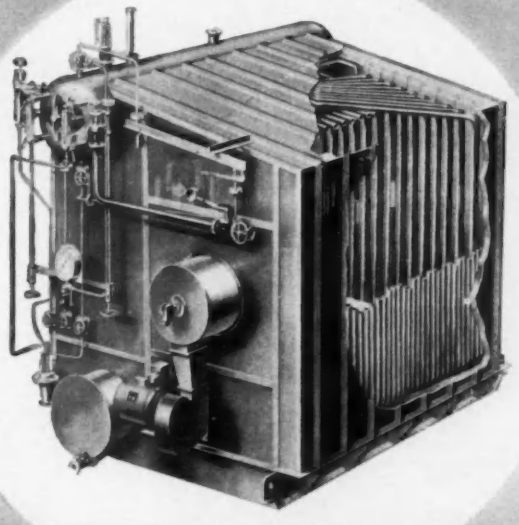
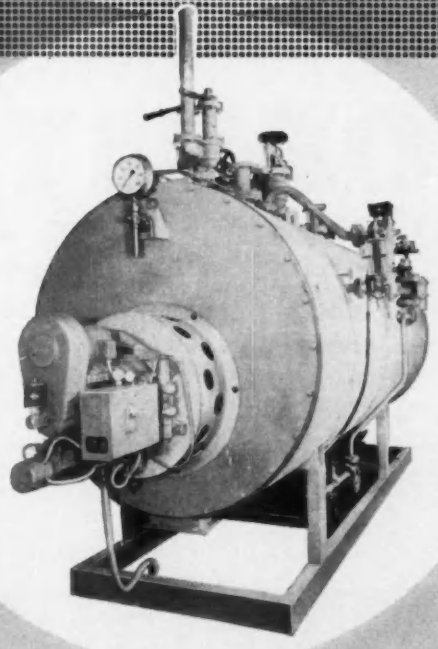
HIGH EFFICIENCY PACKAGE BOILERS



WATER TUBE PACKAGE BOILERS

Two-drum water tube boiler delivered as a packaged unit complete with auxiliaries except feed pump and automatic control equipment which are supplied as optional extras. Superheater also supplied if required. Burns oils up to 3,500 secs. viscosity. Sizes: 12,500; 17,500; 23,500; 28,500 32,500; 40,000 lb./hr. Working pressures up to 450 lb. sq. in. Delivered ready steam-tested.



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Sturdy packaged unit complete with all auxiliaries and fully automatic control. Single flue, 3-pass system with induced draught. Oil heater fitted. Burns oils up to 3,500 secs. viscosity. Sizes: 5,500; 7,500; 10,000; 12,500; 15,000 lb./hr. Working pressure 150 lb. sq. in. Delivered ready steam-tested.

JOHN THOMPSON

JOHN THOMPSON LIMITED · WOLVERHAMPTON

Please address enquiries to THE PACKAGE BOILER DEPARTMENT.

JOHN THOMPSON GROUP

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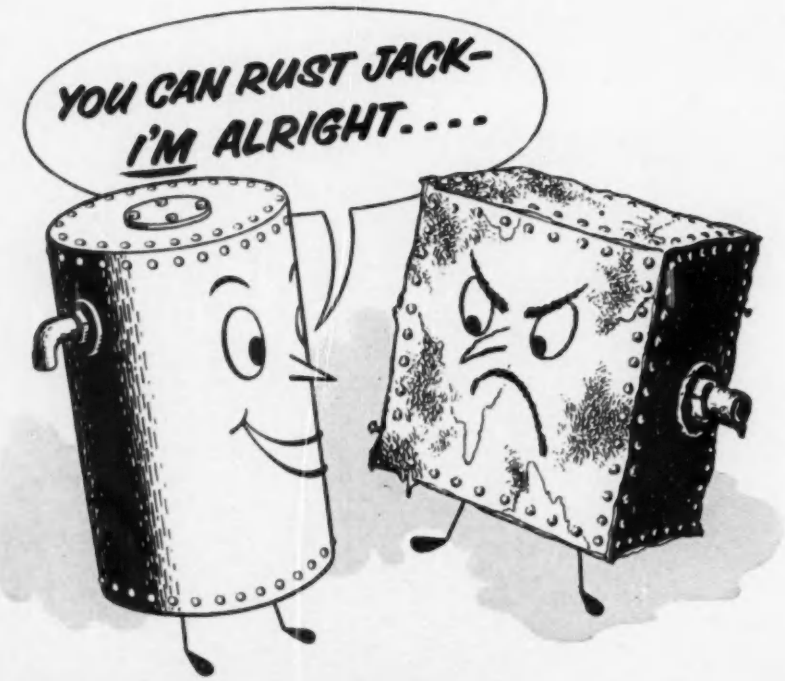

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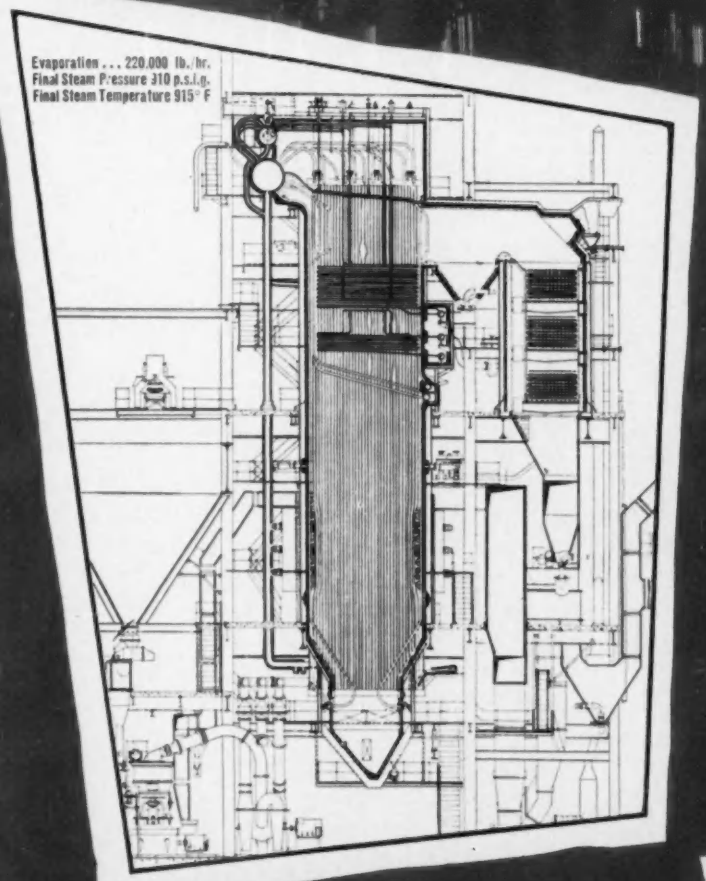
Steam raising for industry



IC build boilers to suit the individual steam raising requirements of every industry.

Whatever the problem, IC steam generating equipment ensures the best use of fuel resources.

Allied equipment covers every requirement from fuel handling to ash disposal.

An example of an installation at a large British paper mill is illustrated here.

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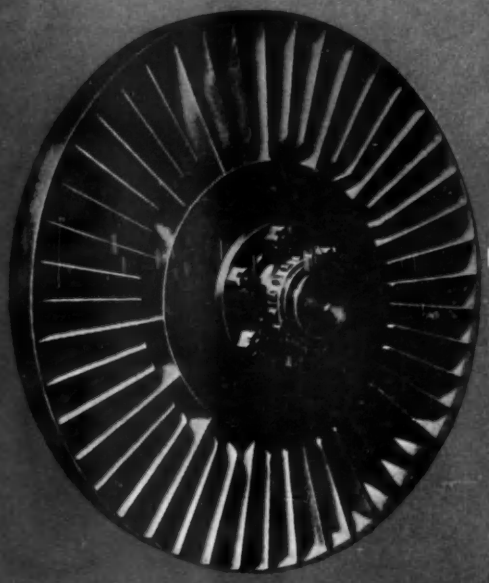

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- 10% to 15% saving in power effected by infinitely variable speed regulation.
- At 'blow off' condition reduced pump speed considerably lowers discharge pressure.
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- Simplest electrical equipment and maximum reliability.

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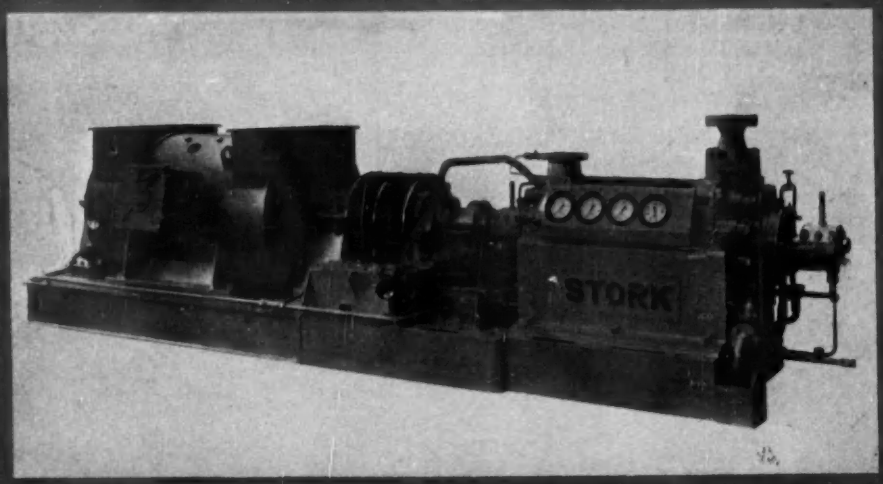

Vulcan-Sinclair size 16 STV fluid coupling transmitting 800 h.p. at 2930 r.p.m. driving a Stork pump in a Dutch power station.

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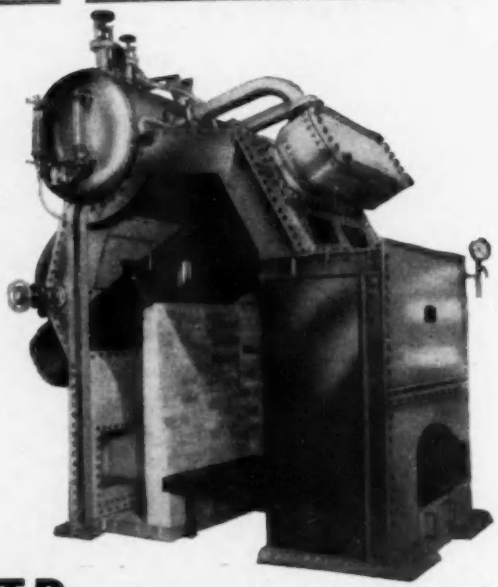

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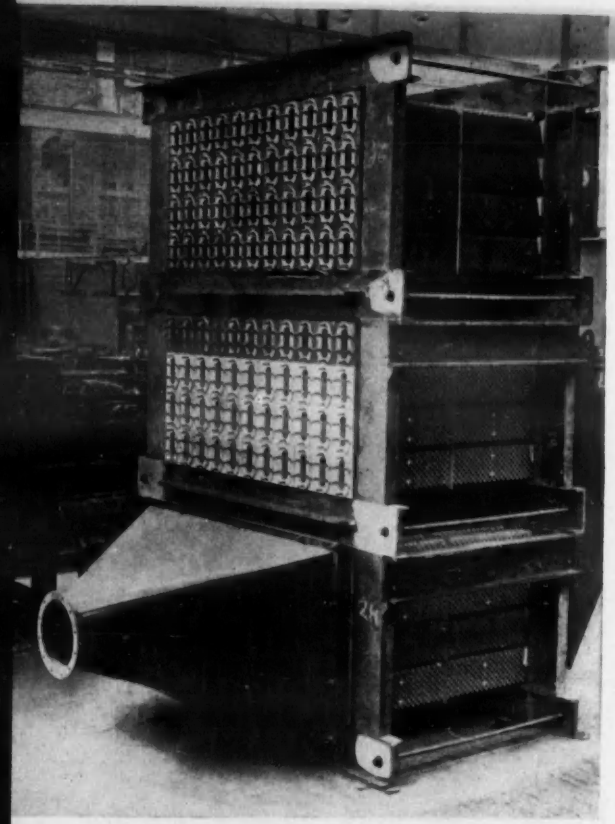

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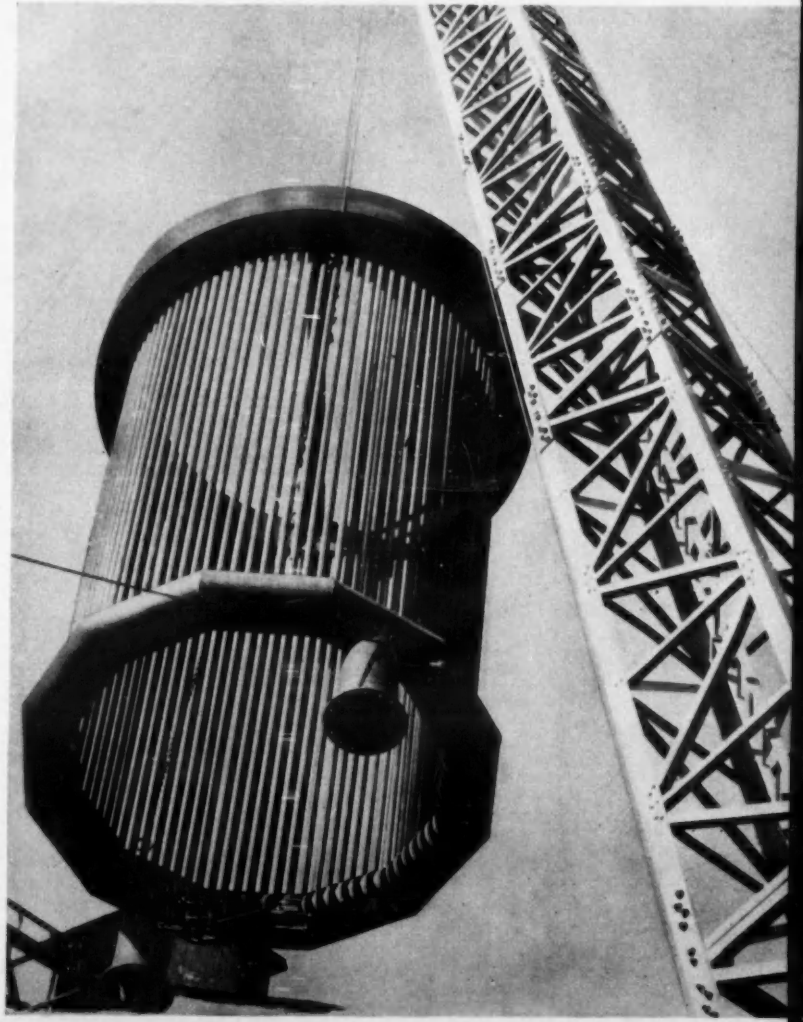
LEFT AND ABOVE LEFT: *Newton Needle type recuperators.*

RIGHT: *Inka tube bundle being lowered into position.*

Newton Chambers

ENGINEERING DIVISION



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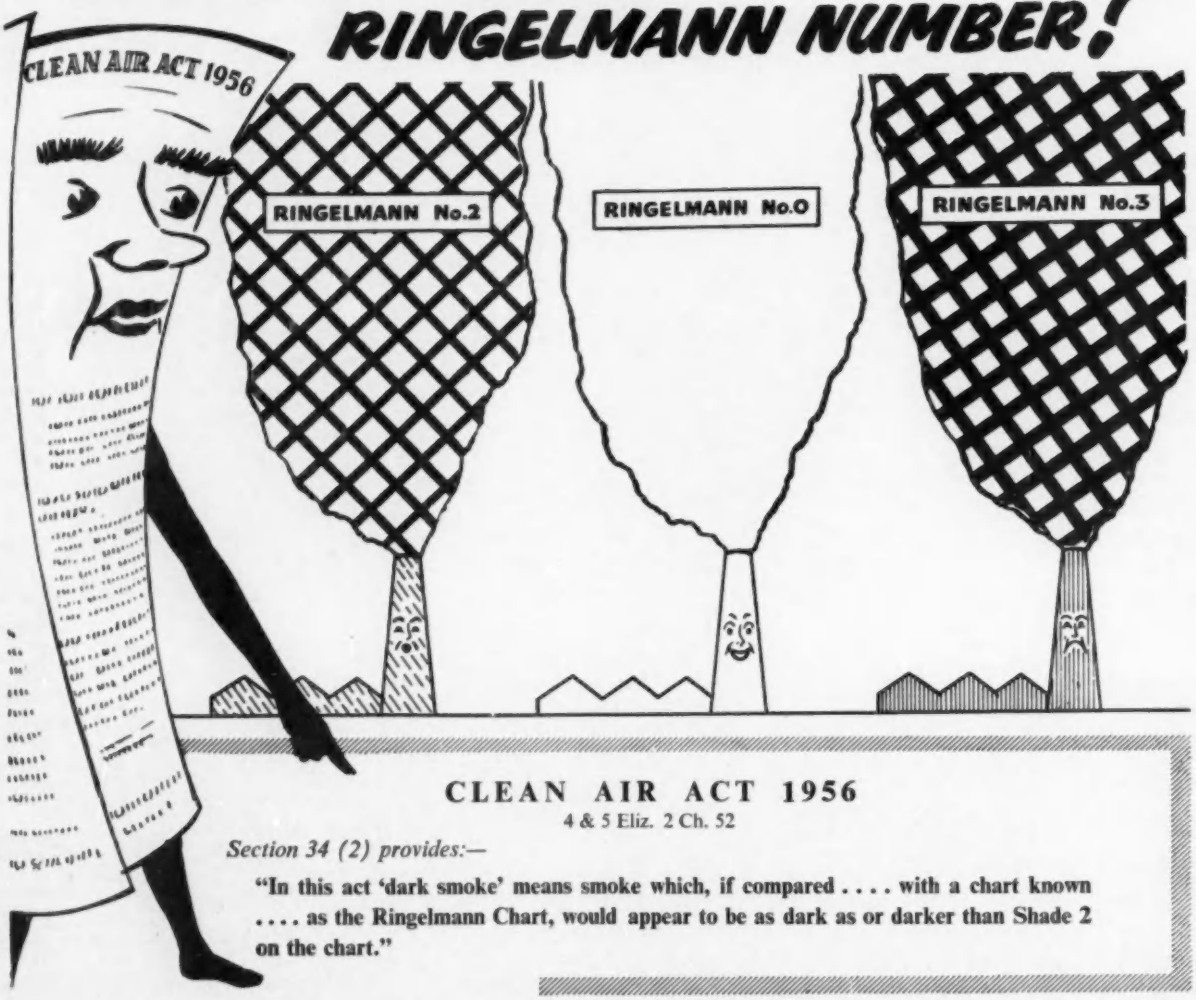

CLEAN AIR ACT 1956

4 & 5 Eliz. 2 Ch. 52

Section 34 (2) provides:—

"In this act 'dark smoke' means smoke which, if compared .... with a chart known .... as the Ringelmann Chart, would appear to be as dark as or darker than Shade 2 on the chart."

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IS ASSURED WITH THE

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CHAIN GRATE STOKER
which anticipated the Clean Air Act by 14 years

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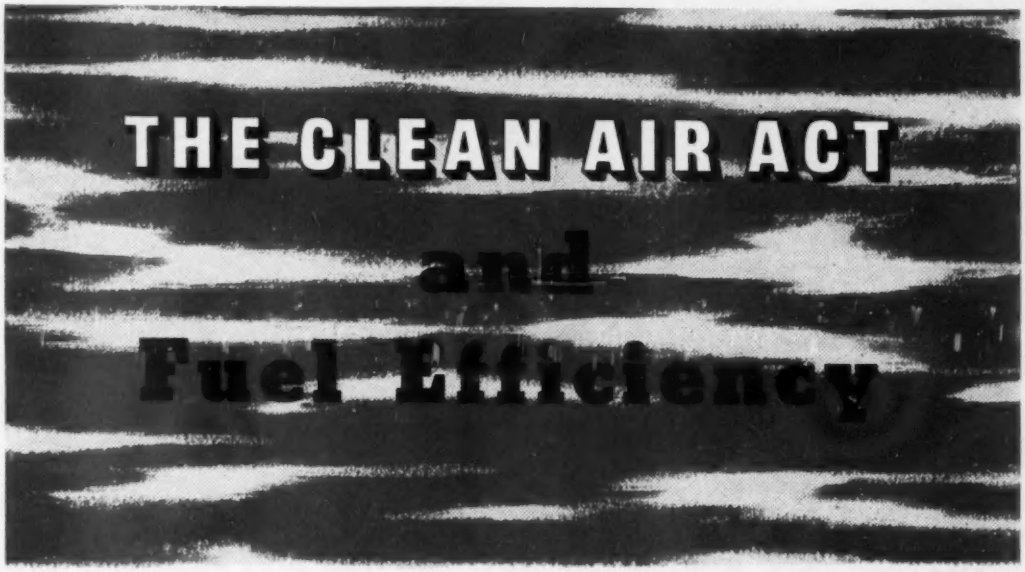

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Application can be made for a government loan to purchase or we can supply on rental. Most mechanical stoker installations will pay for themselves in coal saving alone within the first one to two years.

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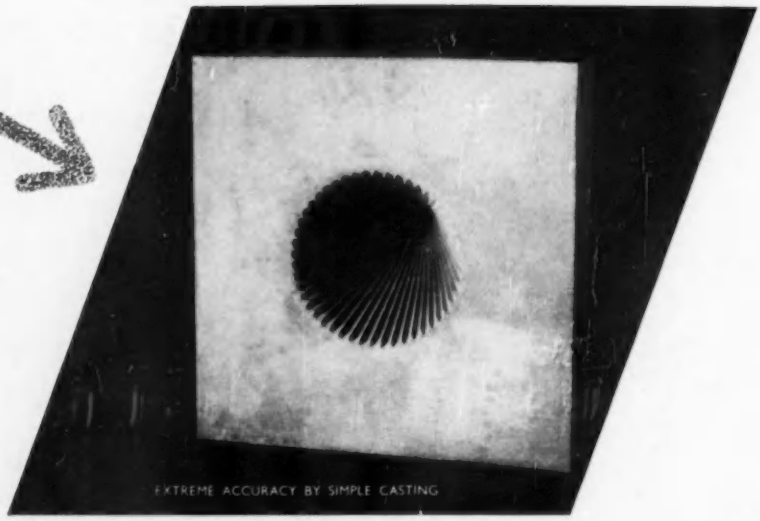
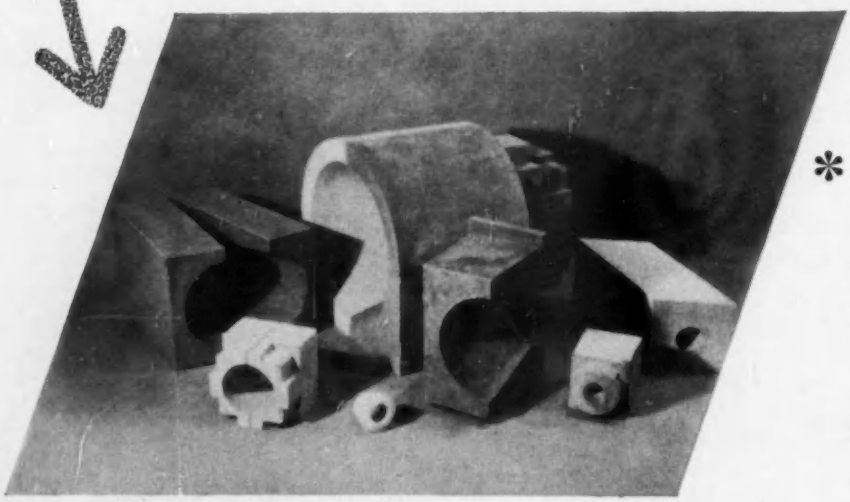
CAST YOUR OWN BURNER BLOCKS * WITH REFRACTORY CONCRETE



EXTREME ACCURACY BY SIMPLE CASTING



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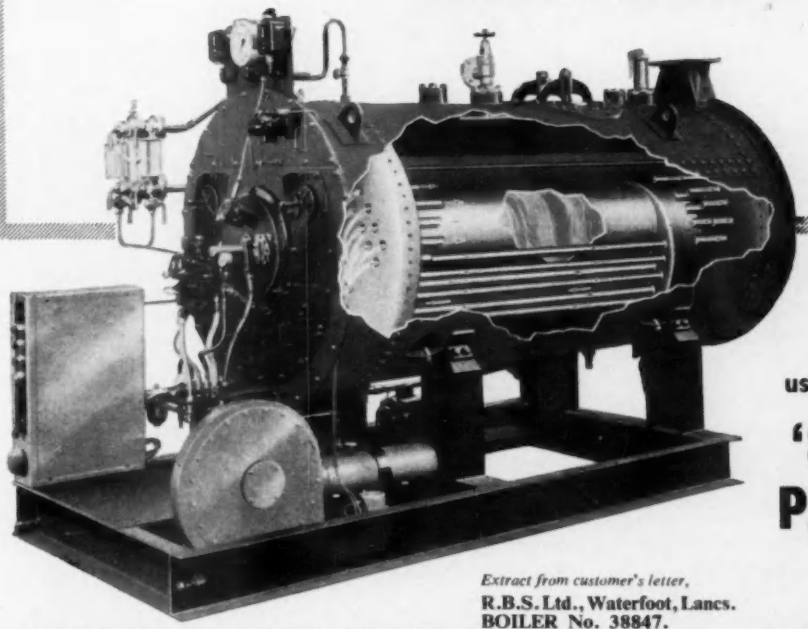
PACKAGE BOILERS

SEPARATE REAR TUBE PLATES AND WATER COOLED COMBUSTION CHAMBERS ARE NOT NEW. THE CRADLEY STEAMPACKET INCLUDED THIS IMPORTANT FEATURE IN 1954. WITH THIS IS COMBINED THE CRADLEY/RUDLING OIL BURNER WITH ITS AMAZING FLAME AND ALL ROUND RELIABILITY. "STEAMPACKET" REMAINS THE BEST IN PACKAGE BOILERS



for efficiency

and durability

use a British designed and built

'STEAMPACKET' PACKAGE BOILER

Oil-fired and smokeless

Smoke fouls the atmosphere and is a sign of INEFFICIENCY in a boiler ! The best answer to smoke pollution is a Cradley Smokeless Oil-fired boiler. Over 80% efficient. Combustion Chamber overheating and rapid wear of rear firebricks cannot occur owing to special semi-wet back construction. To evaporate 1,010 lb. to 10,500 lb. per hour from and at 212° F.

Extract from customer's letter,

R.B.S. Ltd., Waterfoot, Lancs. BOILER No. 38847. installed June 1954.

" It will interest you to know that before putting the Boiler into regular use, we had a series of tests carried out to determine its thermal efficiency. This proved to be between 83% and 84%. For the past two-and-a-half years, the Boiler has been in use for 24 hours a day, seven days a week and has given completely satisfactory service."

London Agency

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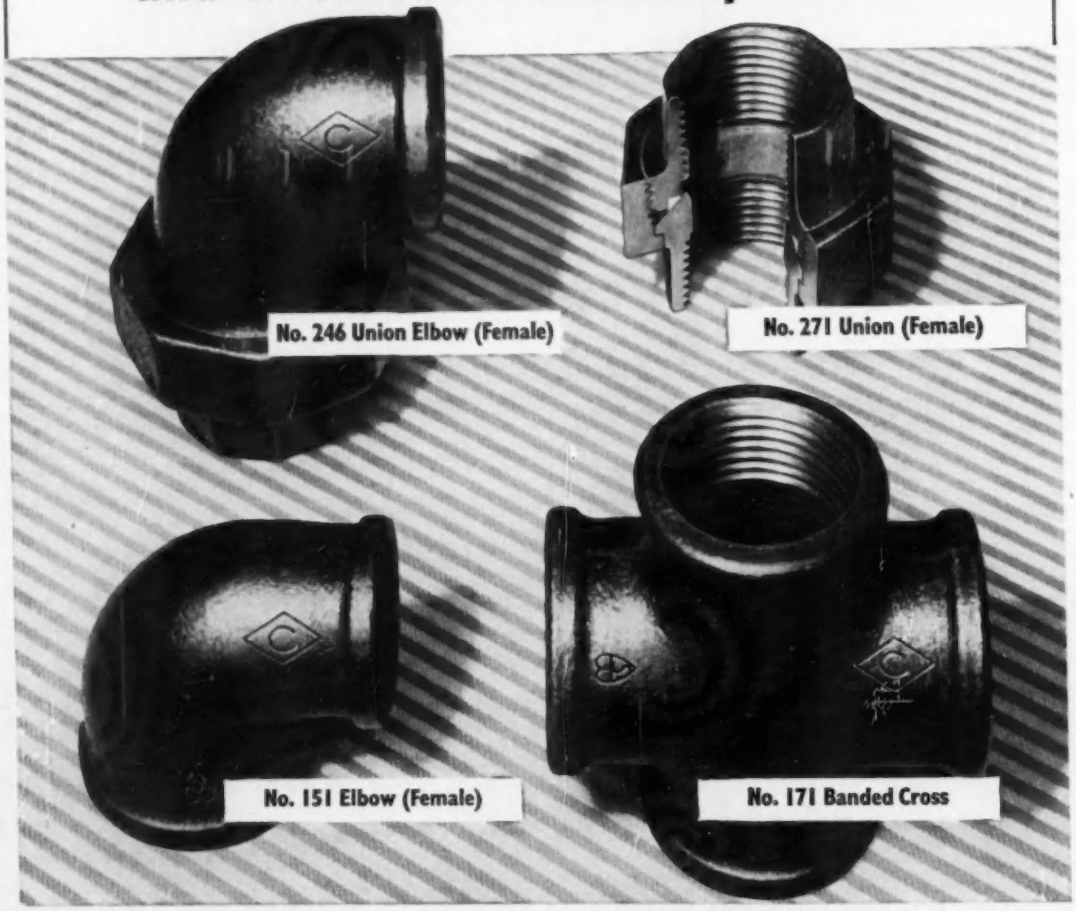
Tel.: **Laburnum 5961.**

Cradley BOILER CO. LTD.

THE CRADLEY BOILER CO. LTD.
Cradley Heath, Staffs., England
Tel.: **Cradley 66003**

All Crane Malleable Iron Pipe Fittings and Unions are individually tested!



The searching tests given to every individual fitting and union at the Crane factory ensure the consistent high quality of these well-known products. Their good appearance, clean finish and dependability have long earned them the confidence of the most exacting buyers.

Plain and Banded Pattern Fittings
All Crane Malleable Iron Pipe Fittings have taper threads and are manufactured to British Standard No. 143. They are available in plain and banded patterns with either black or galvanized finishes. Sizes (equal and reducing) $\frac{1}{8}$" to 6".

All Iron, Railroad, Navy Pattern & Flat-Face Unions
There are four types: Iron to Iron; Bronze to Iron (Railroad) and Bronze to Bronze (Navy) — all with spherical seats; and Flat-face gasket type. All have British Standard taper threads. Sizes $\frac{1}{8}$" to 4". *Write for full details.*

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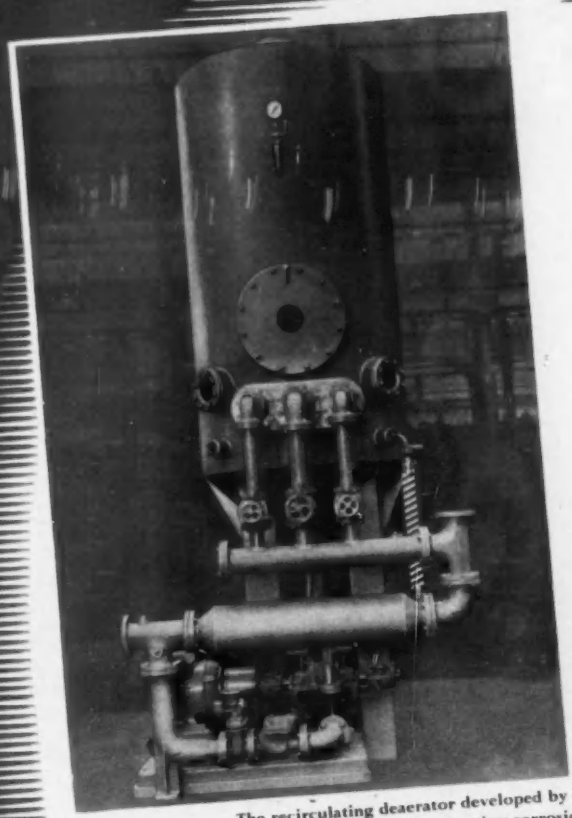

Spray Type deaerator for 100,000 lb/hour

Industrial Deaerators

The recirculating deaerator developed by Hick Hargreaves provides a simple and dependable means of preventing corrosion by reducing the oxygen content of the feed water. Effective deaeration is assured under all conditions of flow, no matter how wide or rapid the fluctuations in the feed rate, whilst the absence of floats and spray valves ensures great reliability. Three types are available. The Straight Spray Type is suitable for handling feed water from 130°F (55°C) to 200°F (95°C) and requires no heating steam for its operation. The Direct Contact Heating Deaerator accomplishes the dual purpose of deaerating and heating cold water up to a maximum outlet temperature of 180°F (82°C).

The pressure type deaerator is capable of operation with outlet temperatures up to 240°F (115°C

Standard designs for all types are available with capacities from 20,000 lb/hour (10,000 kgs/hour) to 450,000 lb/hour (200,000 kgs/hour).

Hick Hargreaves

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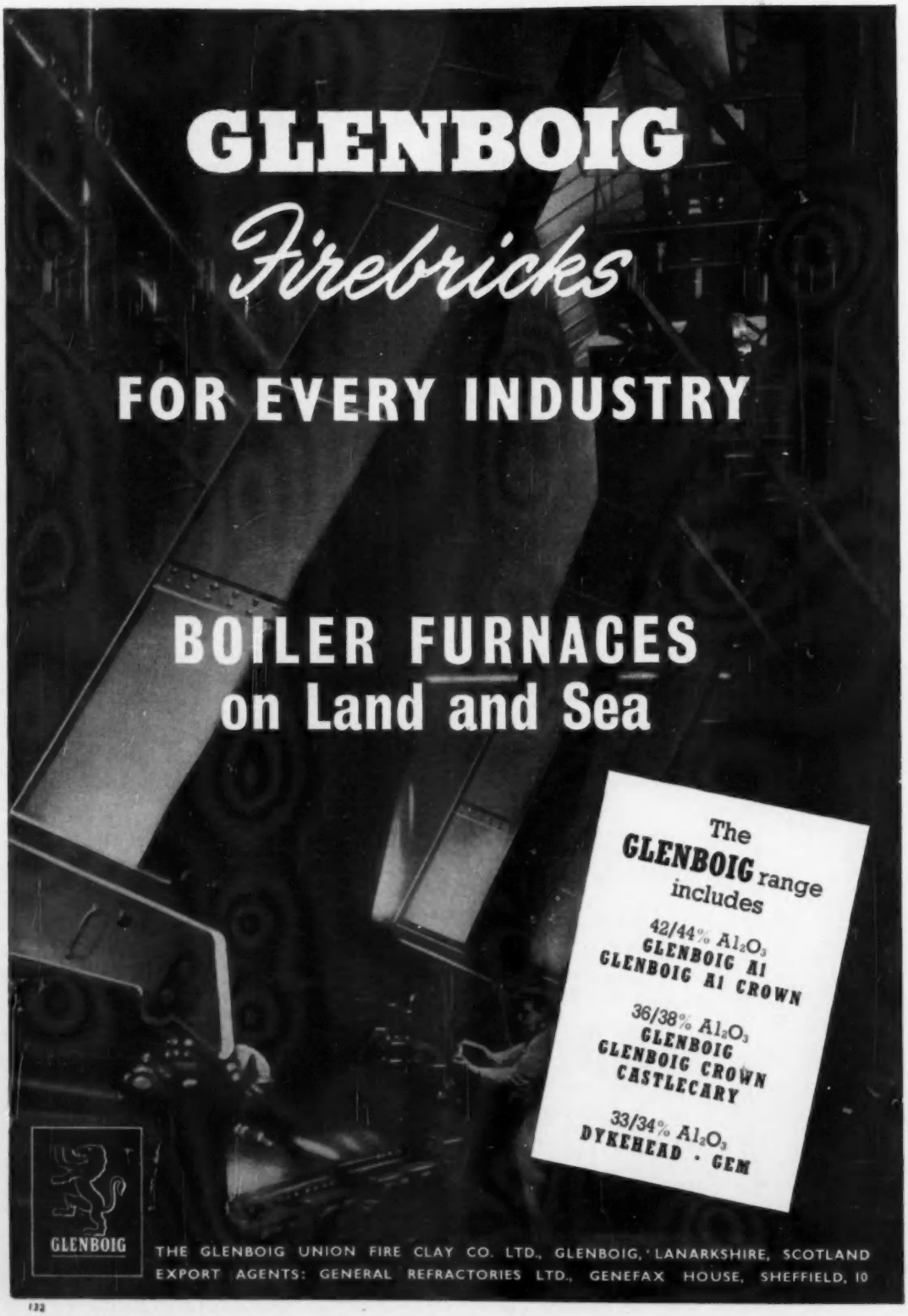
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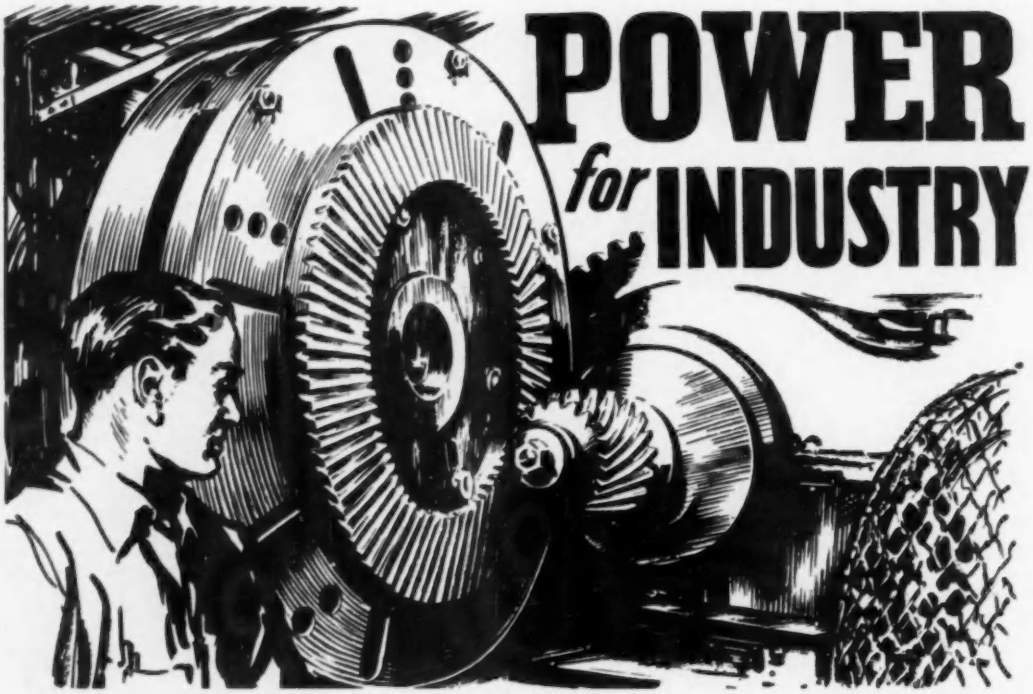

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OIL AND COAL
BY ROAD, RAIL & WATER

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Our Technical Advisory Staff are available for consultation on all problems concerning the most effective use of these fuels, ***and compliance with the Clean Air Act 1956.***

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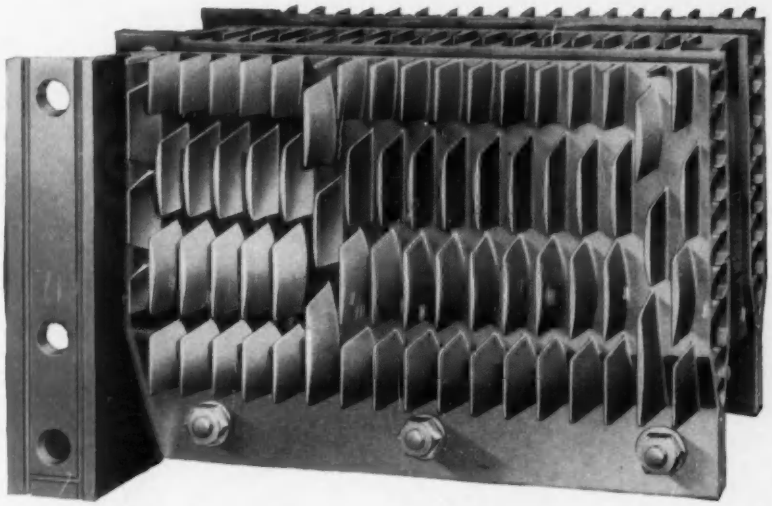
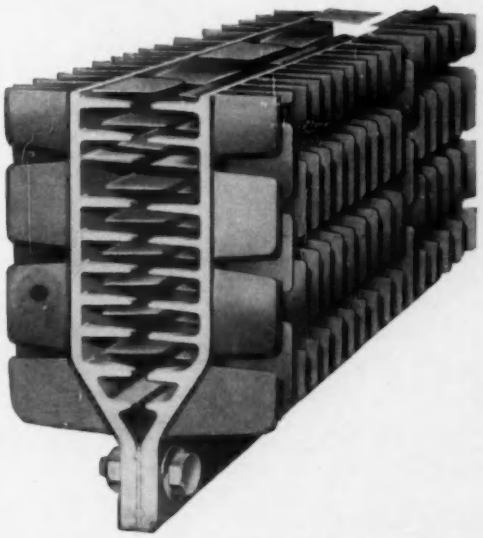


The KABLITZ-GREEN Cast Iron AIRHEATER



A modern plate-type extended surface air-heater, made of high grade cast iron. The corrosion-resisting properties of cast iron have long been established, and the life of the Kablitz-Green Airheater should be several times that of steel constructions.

The design is such that the slightly curved and slightly staggered fins, with high gas velocities, give high heat transfer rates with minimum air and gas draught losses. The installations are therefore very compact, with the advantage of lower building costs and of shorter ducting.

No driving mechanism is involved and there are no power costs. The design minimises deposition, but where cleaning is necessary it can be done by any conventional system.

Further particulars available on request.

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GREEN'S ECONOMISER

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easily arrested at low cost

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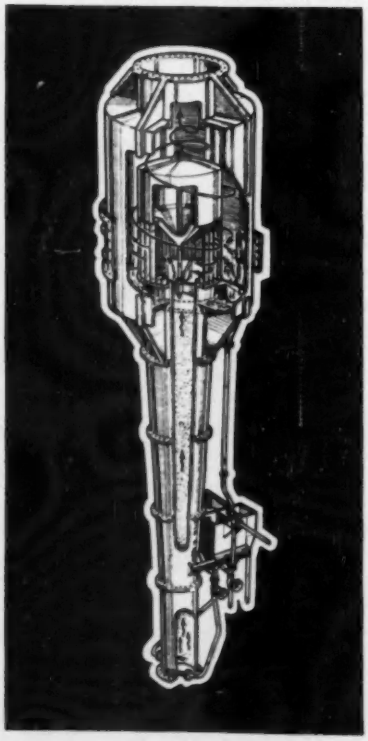
The problem of installing new or replacing old dust recovery equipment is now facing many industrial managements. New plant can be very costly especially if the scheme is not approached properly from the outset.

Thermix Industries Ltd. are pleased to make available their many years' experience in selecting the most economical and technically suitable system of dust control and recovery for each duty from their extensive range of equipment.



We have recently joined the Dunford & Elliott Group and the immediate benefits to clients are highly competitive prices, Laboratory and Test Plant Facilities and first-class After-Sales Service.

The THERMIX range of products includes:

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Multi-tubular Dust Collectors

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The most versatile steam trap yet

Unaffected by superheat, waterhammer, vibration, corrosive condensate and freezing

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Works in any position

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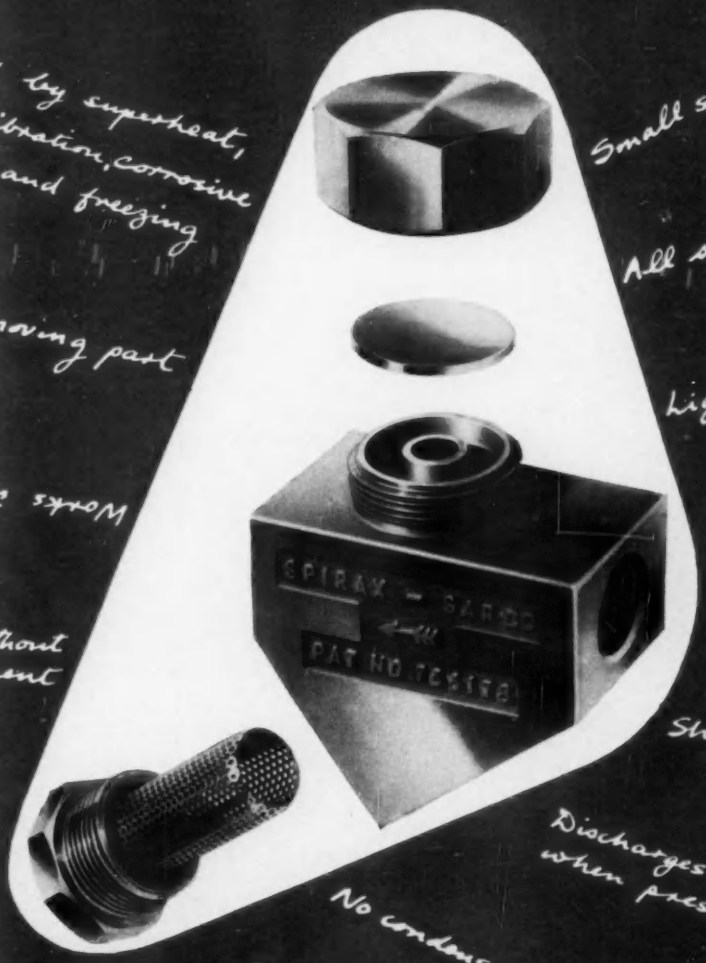

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All stainless steel

Light weight

Up to 550°F.

Shuts tight on no load

Discharges condensate when present

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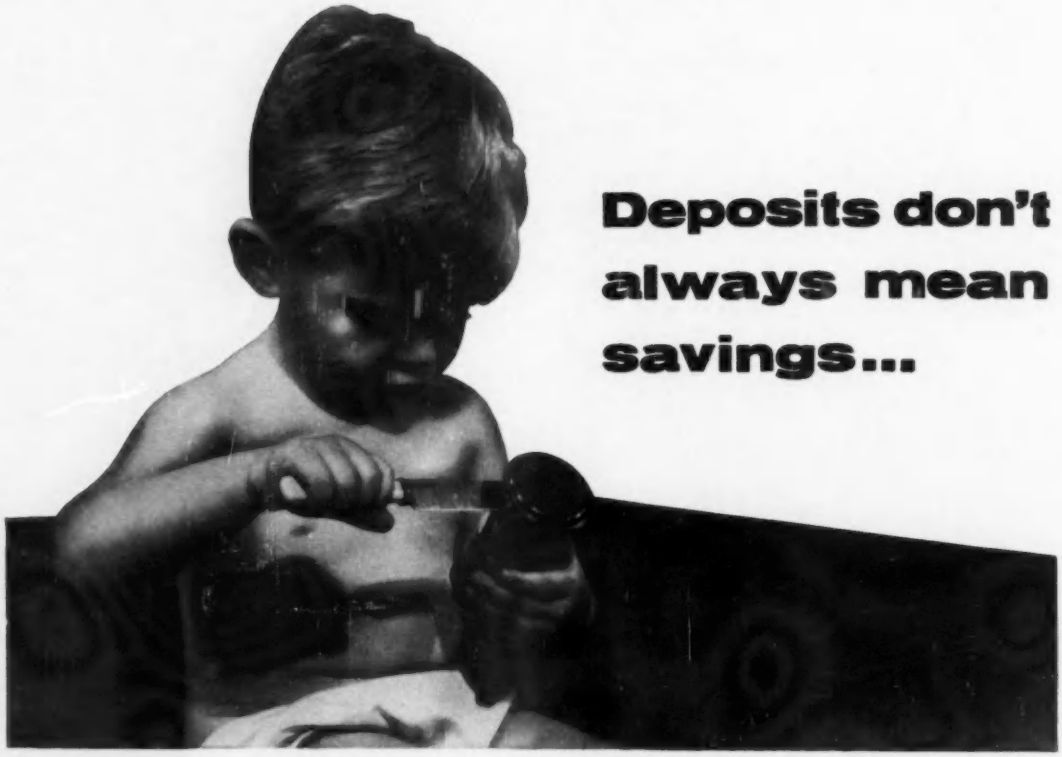

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Carbonaceous deposits, for example, in oil-fired heating systems result in wasted fuel and loss of heat transfer. FUELSLIP fuel oil additive contains a combustion catalyst which makes it possible to burn *completely* the products of incomplete combustion and so avoid their binding action on carbonaceous matter thus eliminating the cause of malignant deposits. This in turn results in a reduction in the amount of water absorbed and thus corrosive sulphuric acid formation is minimised. All this means that you enjoy increased fuel efficiency *and* economy!

We shall be pleased to supply you with fully descriptive literature and give you the name of your nearest Slip distributor There are Slip Agents all over the world ready to advise and serve your overseas interests.

Fuelslip

FUELSLIP is backed by a comprehensive technical service to help you use your fuel productively. Knowing the causes for lack of fuel efficiency to be many and varied, Slip's extensive laboratories give careful consideration to the conditions of each individual user. Thus Slip are able to ensure that *you* make the most of the fuel that *you* burn.

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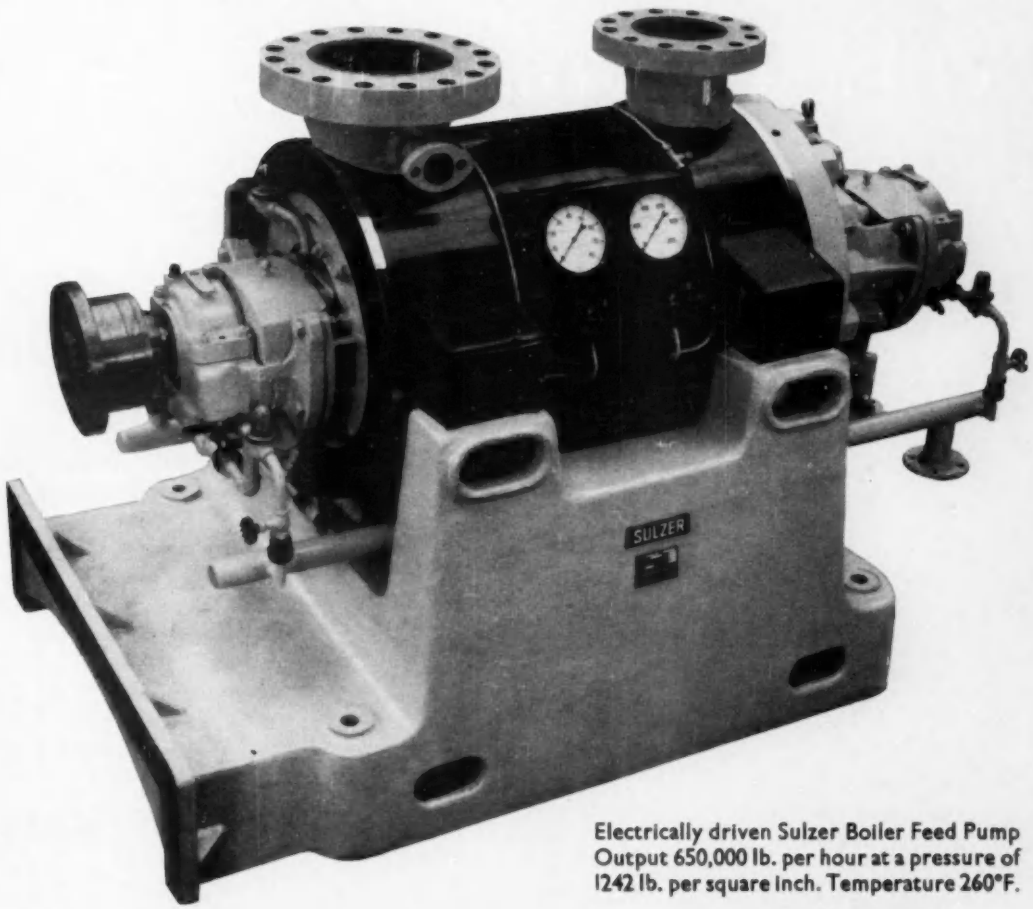
BOILER - FEED PUMPS



Electrically driven Sulzer Boiler Feed Pump
Output 650,000 lb. per hour at a pressure of
1242 lb. per square inch. Temperature 260°F.

one of nine units for
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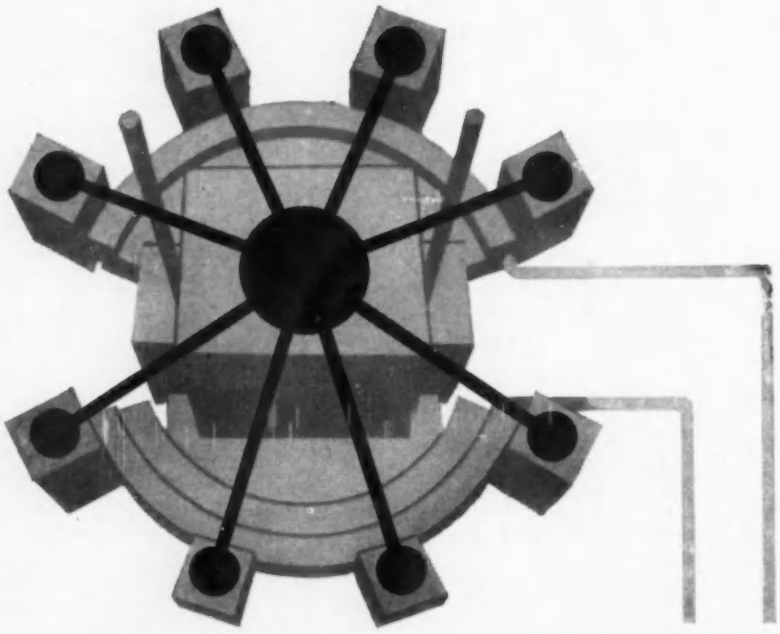
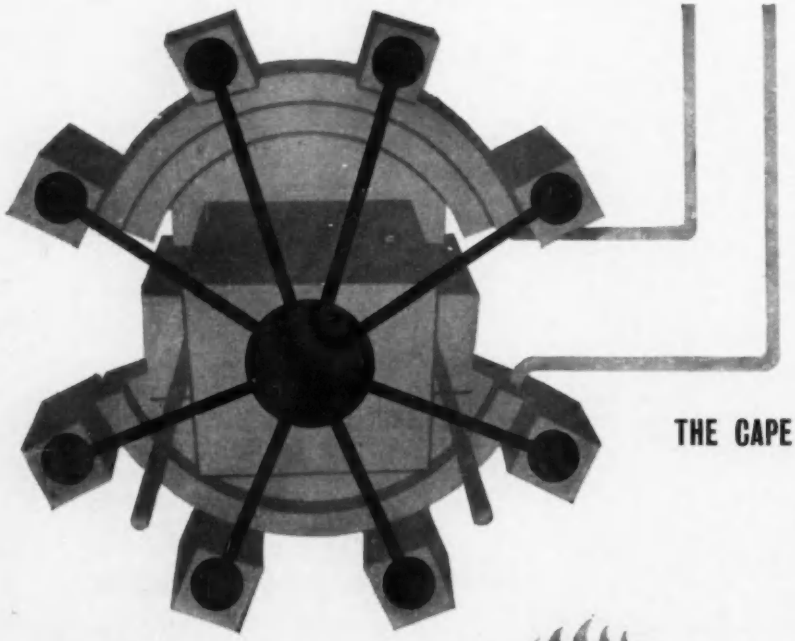


BERKELEY—a challenge to insulation



The heat developed by the twin reactors of the new Berkeley atomic power station poses problems of thermal insulation which will require new techniques in their solution. Confining and controlling such intense yet precious thermal energy constitutes a challenge—a test worthy of the knowledge and skill acquired in 65 years' experience of thermal insulation manufacture by The Cape Asbestos Company, to whom the contract has been entrusted.

THE CAPE ASBESTOS COMPANY LIMITED

Manufacturers of:

CAPOSITE
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At the Berkeley Nuclear Power Station of the Central Electricity Generating Board, the contract for supplying and installing thermal insulation for the TWO REACTOR PRESSURE VESSELS, 16 HEAT EXCHANGERS, THE CO_2 DUCTING AND MAIN STEAM PIPES has been awarded by the main contractors AEI- John Thompson Nuclear Energy Co. Ltd., to The Cape Asbestos Company Limited.

CAPE

ASBESTOLUX asbestos insulation board, **MARINITE** asbestos sheet and **CAPASCO** moulded brake linings and clutch facings are also manufactured by the Cape Asbestos Group of Companies.

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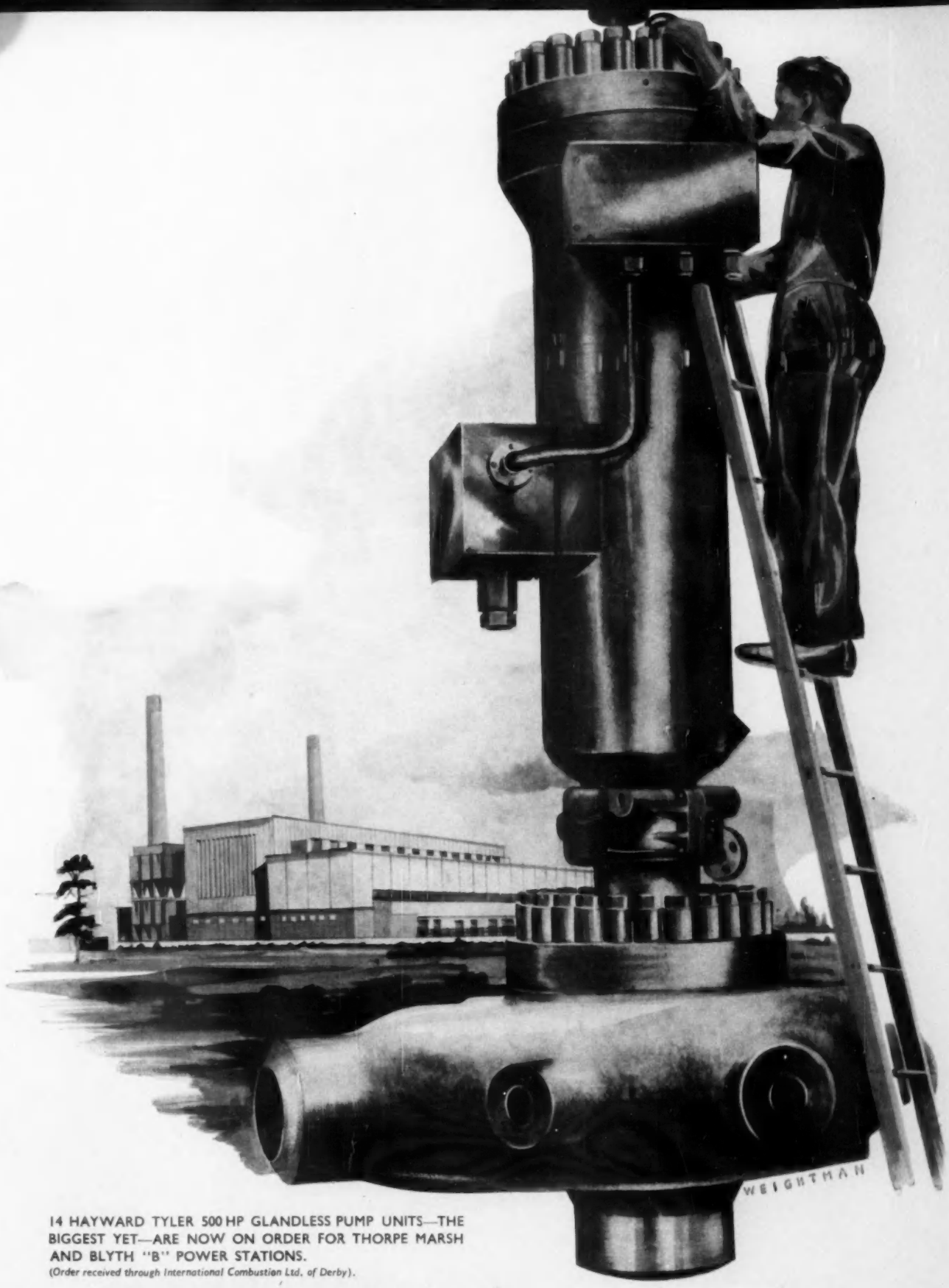

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(Order received through International Combustion Ltd. of Derby).

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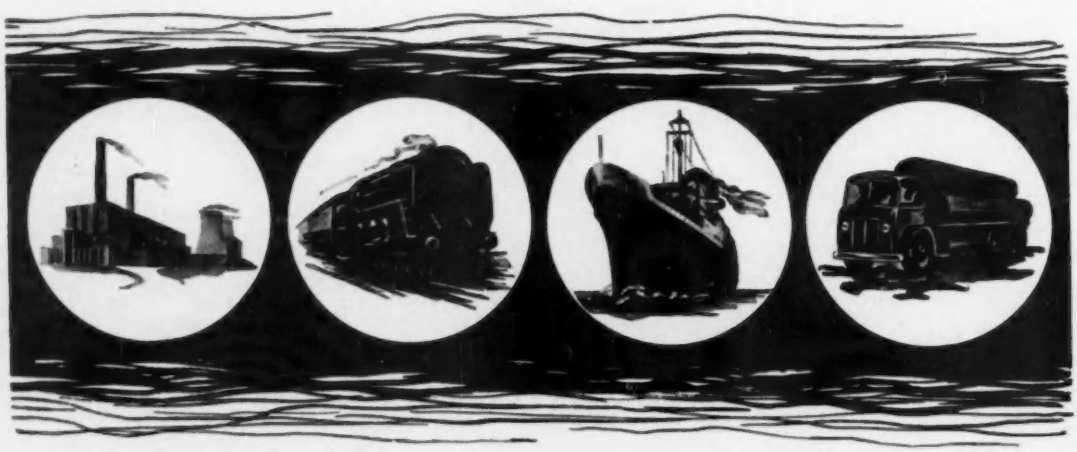

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What makes a good boiler so good?
What's behind the name that's in the forefront of boiler design?
You can't really put the finger on any single aspect. It's a team job, a combined operation, a whole pack train of skills co-ordinated under the general heading 'know-how'.
It's *the Ruston touch.* Something that comes only after many years of supplying exactly the right type of boiler for a specific duty — whether it's steam raising or hot water supply.
It's the Ruston touch that gives you the Horizontal Thermax, the best three-pass wet back type boiler on the British market . . . the boiler that gives you 80% efficiency . . . the boiler that cuts operating costs to the bone and provides evaporations up to 17,500 lb. per hour.

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HORIZONTAL 'THERMAX' BOILERS

Also available as 'packaged' units with evaporations up to 6,000 lb. per hour.

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Unfortunately corrosion in steam-raising plant cannot be forgotten. It is too costly and damaging in its effects. "Apexior Number 1" is the most economical, *sure* safeguard against corrosion on surfaces in contact with wet temperatures between 175° and 1000°F. Two coats of "Apexior Number 1"—mechanically or brush applied—constitute absolute protection for at least 12 months. After the initial treatment only one coat is necessary. Subsequent descaling is a much simplified process because scale is less, looser and more easily removed from Apexiorised surfaces.

In certain industries it is a most important advantage of "Apexior" that it does not affect the water by taste, taint or smell. For over 50 years, "Apexior Number 1" has been put to work in all types of boilers of leading manufacturers with absolute satisfaction. Let experience be *your* guide; send for a copy of the "Apexior Manual".

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But for cold-wet surfaces up to 125°F.—use "APEXIOR NUMBER 3"

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Valves *and* Boiler MOUNTINGS

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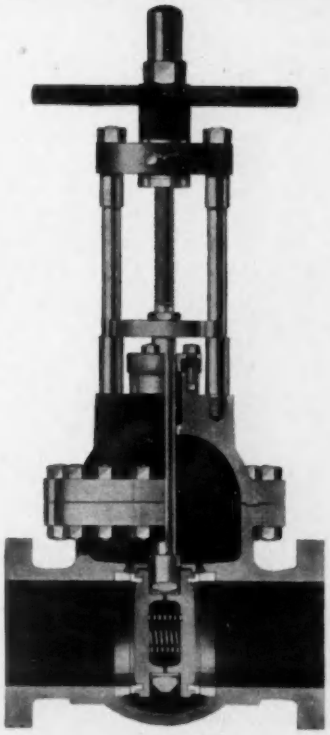
BOILER WATER GAUGE

BRONZE QUICK ACTION PARALLEL SLIDE VALVE



CAST STEEL PARALLEL SLIDE VALVE

SHAW SON & GREENHALGH LTD.
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Ready-to-use
REFRACTORY CEMENT!

Plastic
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The
Time-Saving
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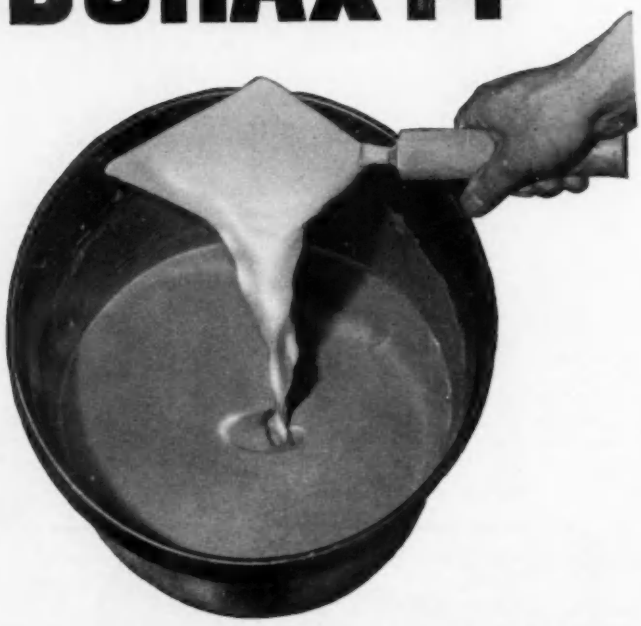
to obtain
THIN STRONG
JOINTS



A ready-to-use jointing mortar supplied in a smooth plastic condition, which may be applied with a trowel in the normal way, or used for "dip and rub" joints.

Durax No. 14 is an aluminous refractory cement which contains a high proportion of pre-calcined material to control shrinkage. It produces thin, solid joints which set hard without the application of heat. These joints are as impermeable to the action of the furnaces gasses as the bricks themselves, resulting in reduced cool air infiltration and improved thermal efficiency.

Designed for use between 1000°C and 1650°C. For lower temperatures Durax No. 4 is recommended.

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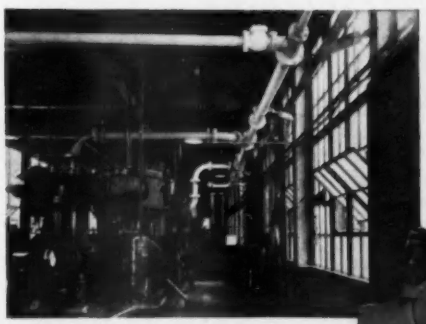
Just one of the many applications for the

VOKES GENSPRING Sway Brace

Here's the Vokes Genspring Sway Brace at work—this time on compressor branch lines at the Ipswich Factory of Crane Ltd. Designed to eliminate shock or vibration, the Non-Resonant Sway Brace is equally suitable for steam lines, exhaust lines, hydraulics and other applications. Available in nine different spring sizes, housed in two sizes of casing, Sway Braces cover an initial loading range from 92 to 1,500 lbs.
Vokes Genspring Constant and Variable Support Hangers, together with the Sway Brace, offer complete pipe support for every type of installation. Send for full details of the Vokes Genspring suspension systems.



Sway Braces in the Compressor House at Messrs Crane Ltd., Ipswich.

Close-up of Vokes Genspring Non-Resonant Sway Braces.

VOKES *Genspring* SUSPENSION SYSTEMS

VOKES GENSPRING LIMITED · GUILDFORD · SURREY

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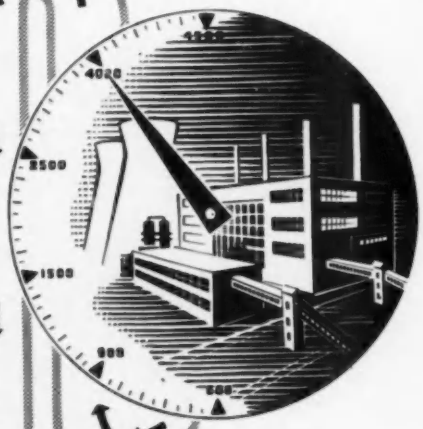
CIRCULATION

Natural Forced and Controlled



whatever the pressure

Today's trends in steam generating are towards higher pressures and capacities and in this field Clarke Chapman are now able to offer controlled and forced circulation types of units (La Mont and Benson patents) in addition to the normal standard equipment.

Clarke Chapman have had many years' experience in the design and installation of large power station and industrial generating plant, and will be pleased to receive enquiries for specialised units to meet any conditions and for all types or mixtures of fuel.

Clarke Chapman

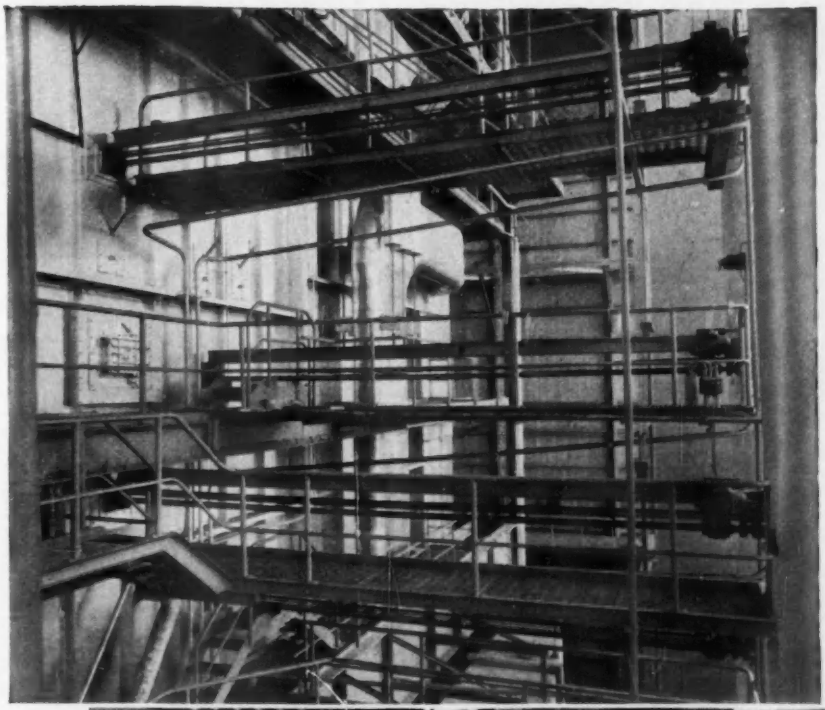
STEAM RAISING PLANT

Water-tube Boilers and Ancillary equipment. Raymond Bowl and "Resolutor" Milling Plant. Fusion Welded Pressure Vessels. Erection Winches. Ash Conveyors.

CLARKE, CHAPMAN & CO. LTD, Victoria Works, Gateshead, 8, Co. Durham

London Office: DUNSTER HOUSE, MARK LANE, E.C.3. Glasgow Office: 116 HOPE STREET, C.2.
Manchester Office: 8 KING STREET, 2.

HOPKINSONS' SOOT BLOWERS
at a Continental Power Station



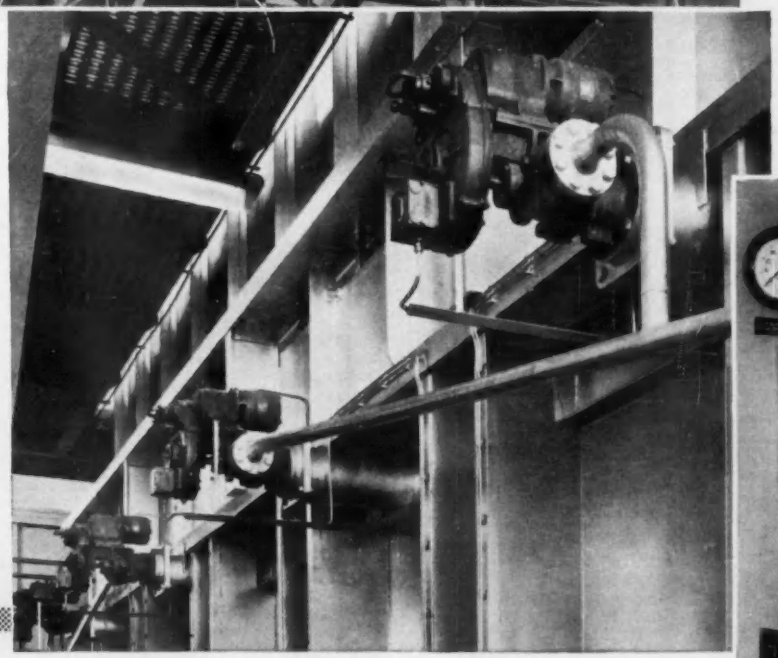
Long Retracting Blowers, sequence-controlled

The photographs show our soot blowing equipment installed at a notable power station in Holland.

Our sequence-controlled blowers give continuity in operation, accuracy of control and characteristic 'Hopkinson' reliability in performance.

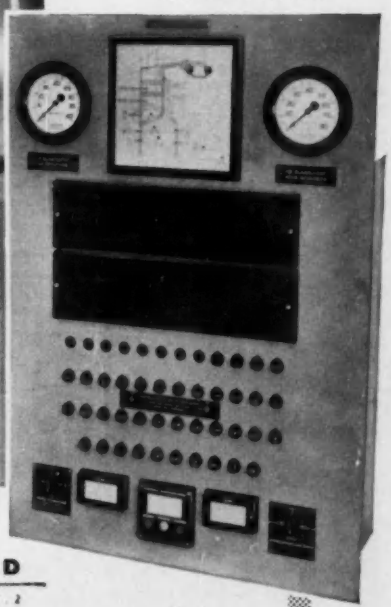
A complete range of equipment is available for every type of water-tube boiler installation.

Photographs by courtesy of Provinciaal Noord-Brabantsche Electriciteits Maatschappij



Rotary Soot Blowers

Soot Blower Cubicle



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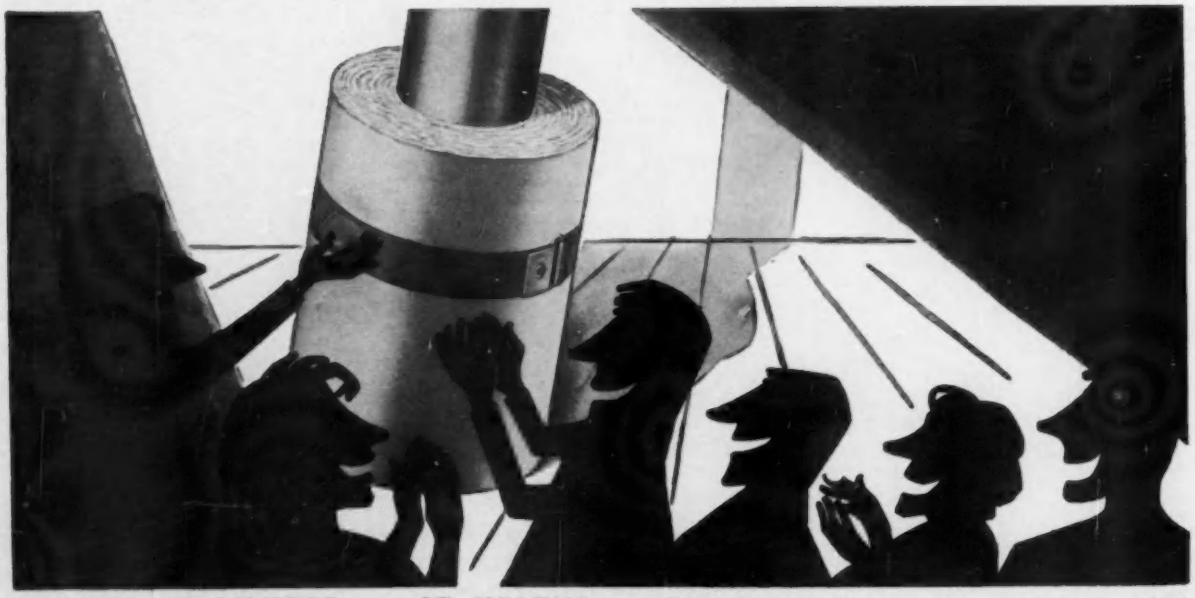

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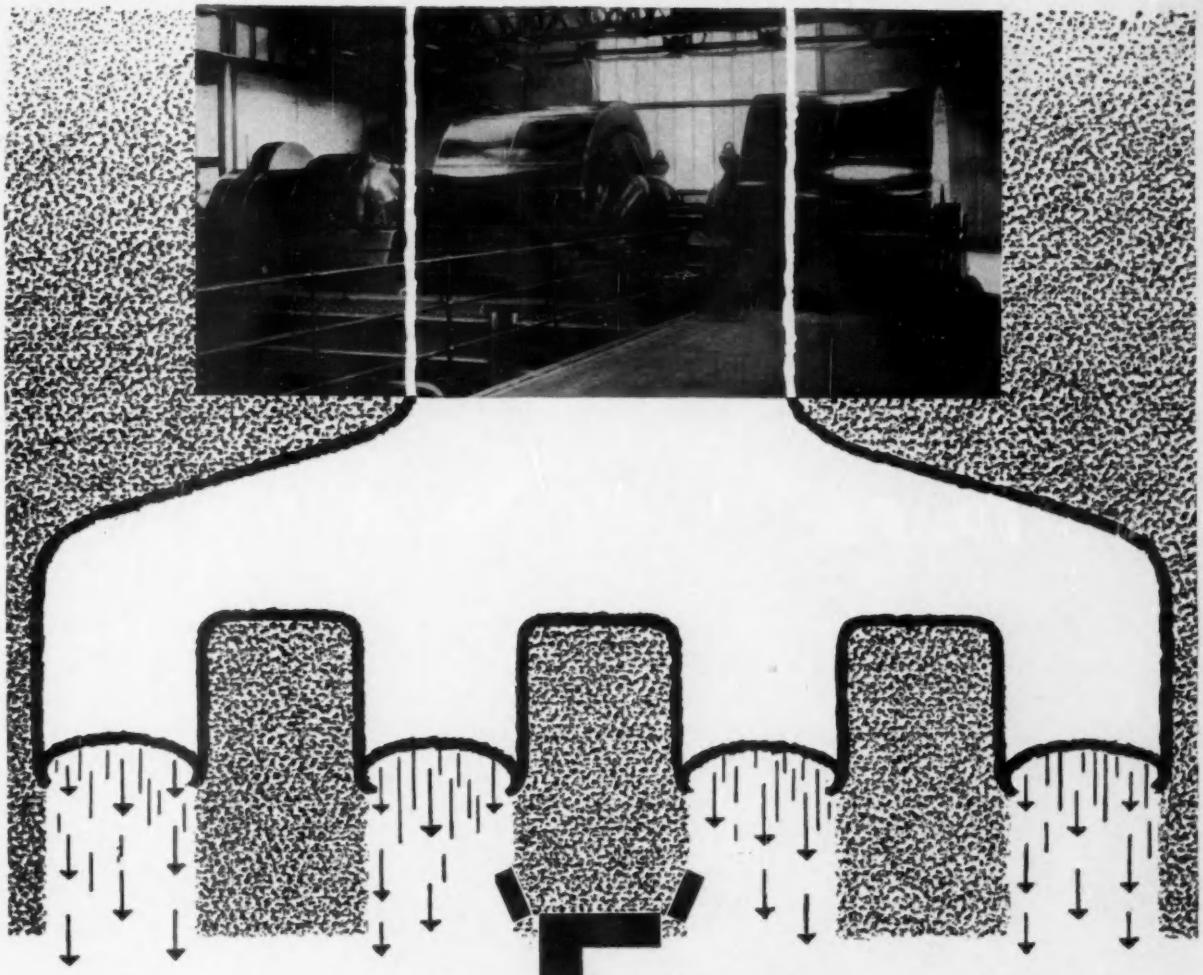

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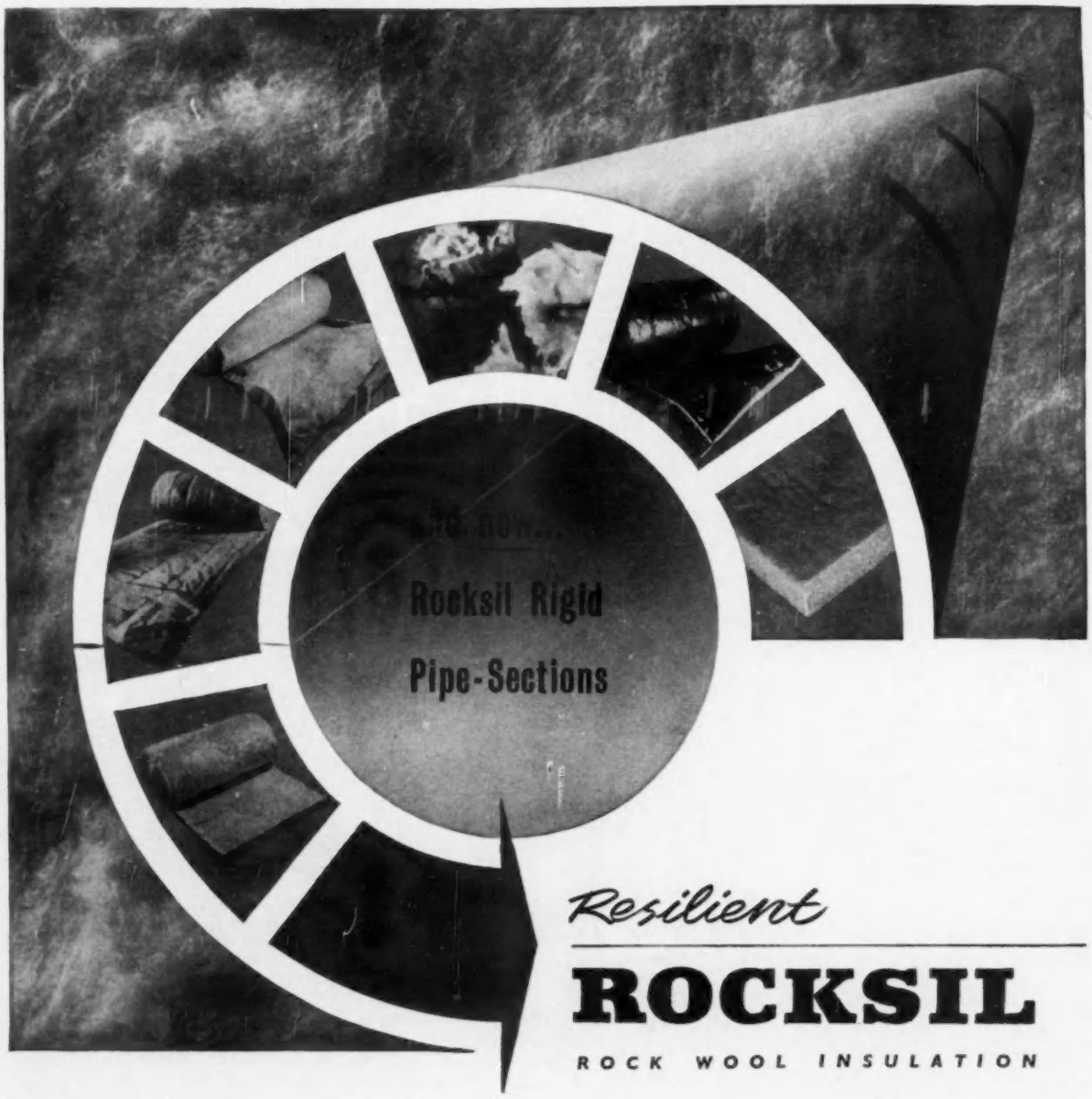

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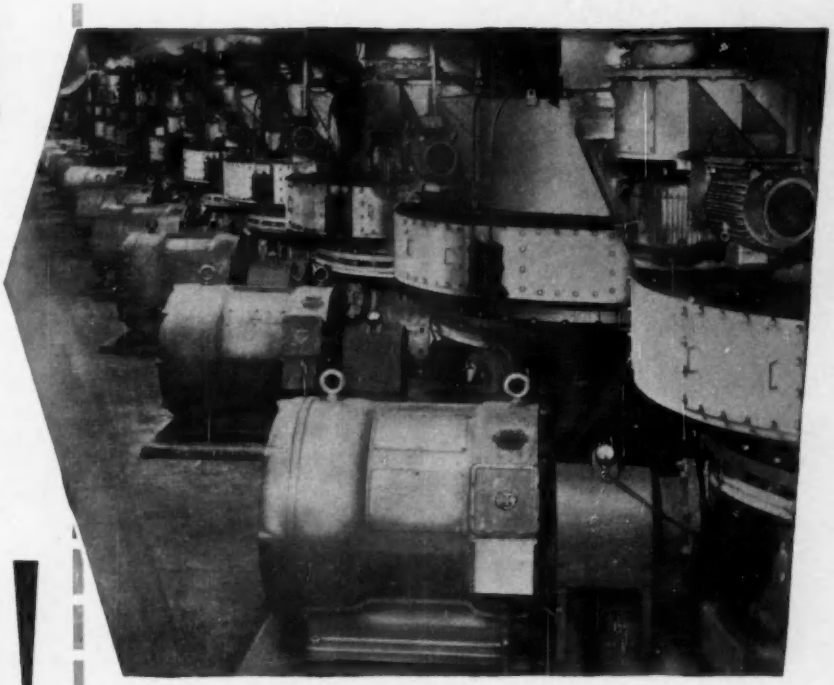

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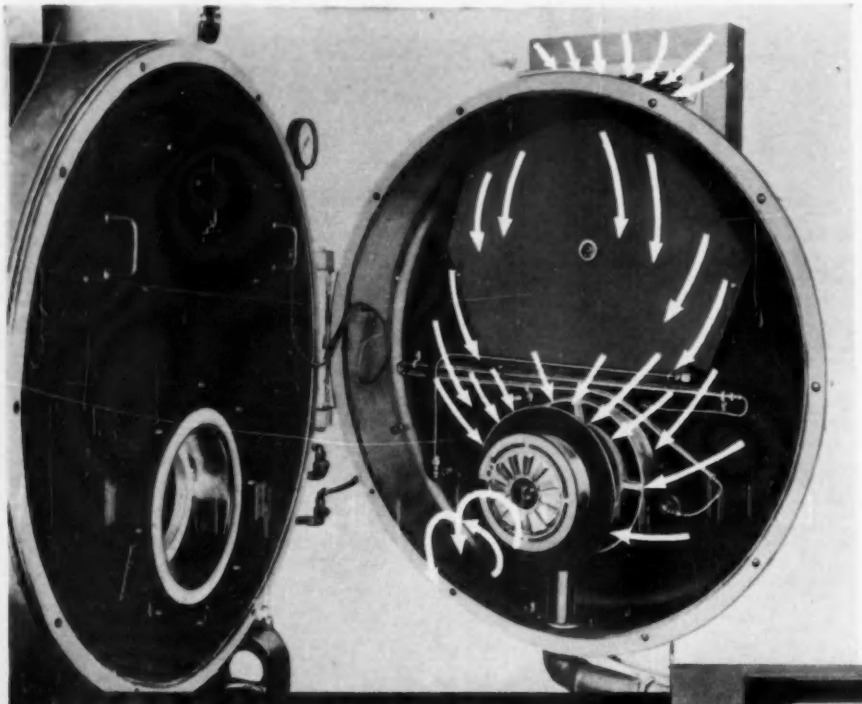

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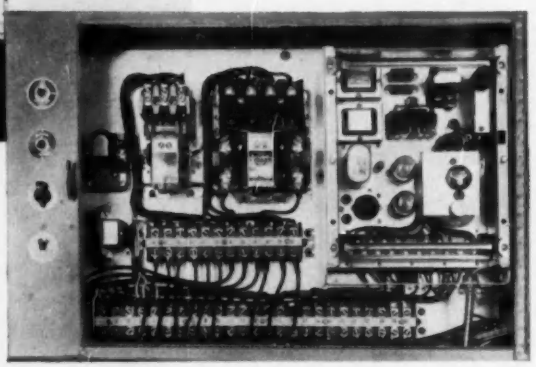

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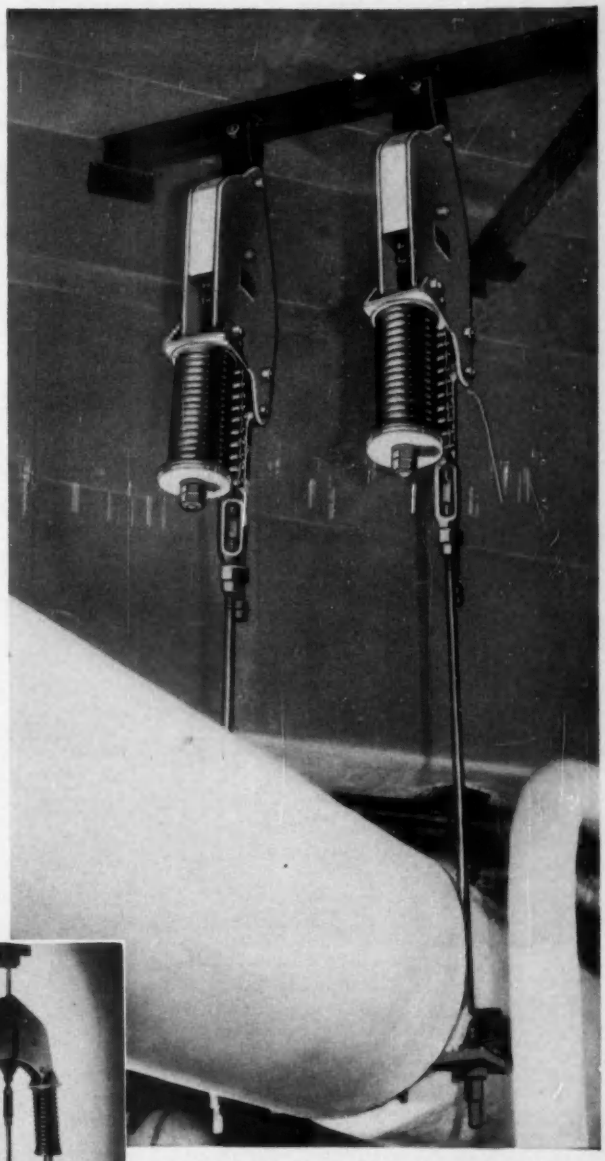
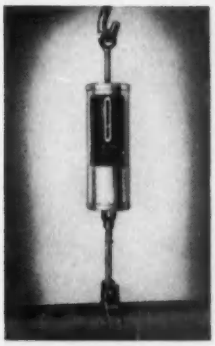


Ferrybridge " B " Power Station. Central Electricity Generating Board, Yorkshire Division. H.P. Steam pipes supplied and installed by Stewarts & Lloyds Ltd.



Leibfried Red Top Pipe Supports for loads from 100 to 5,000 lbs. and total travel of 3".

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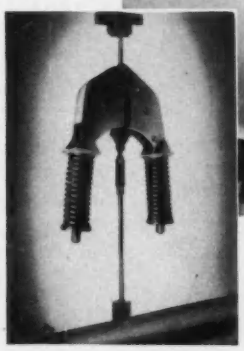

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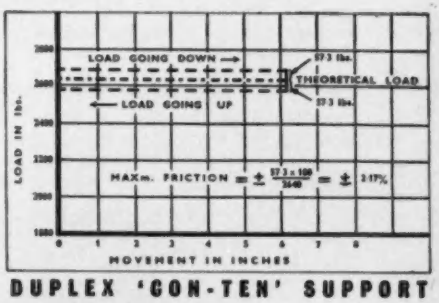

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Alphabet of

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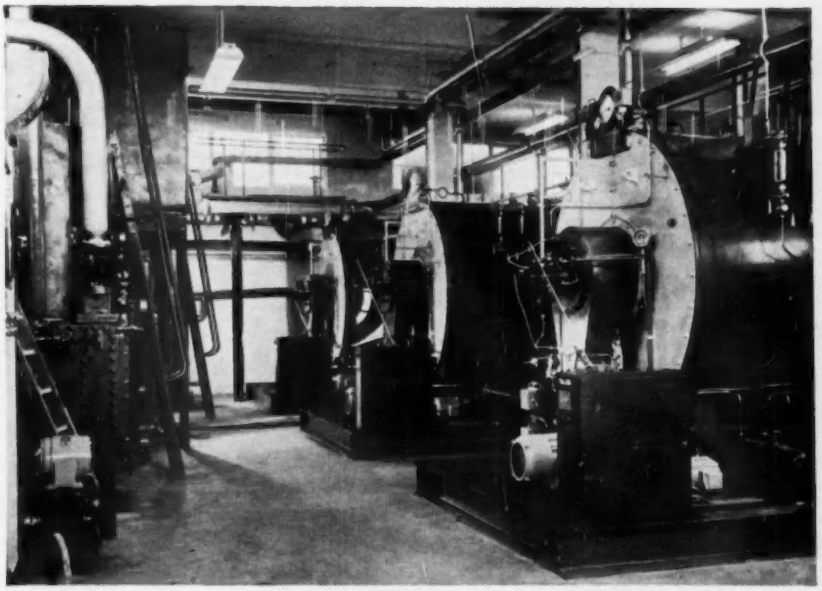

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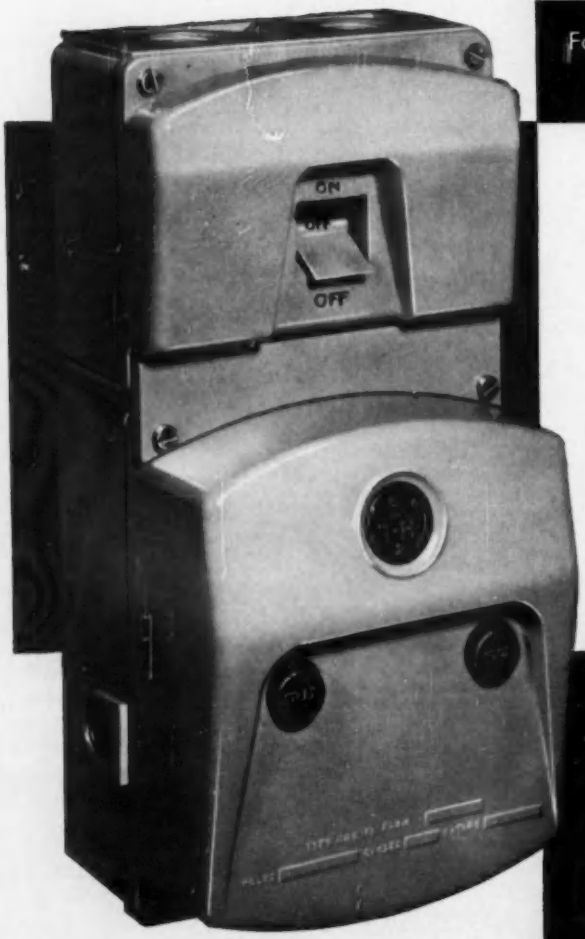

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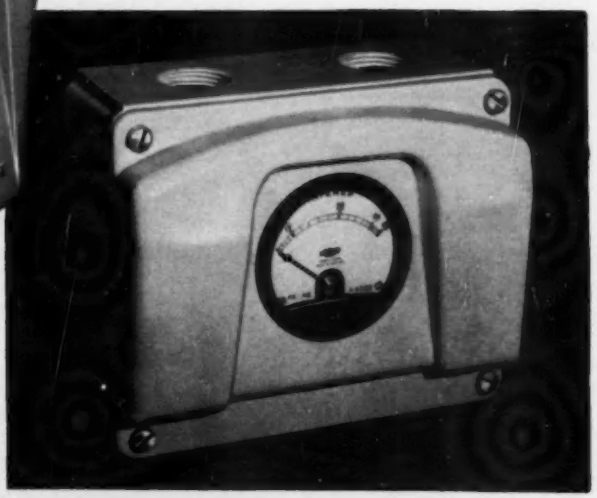

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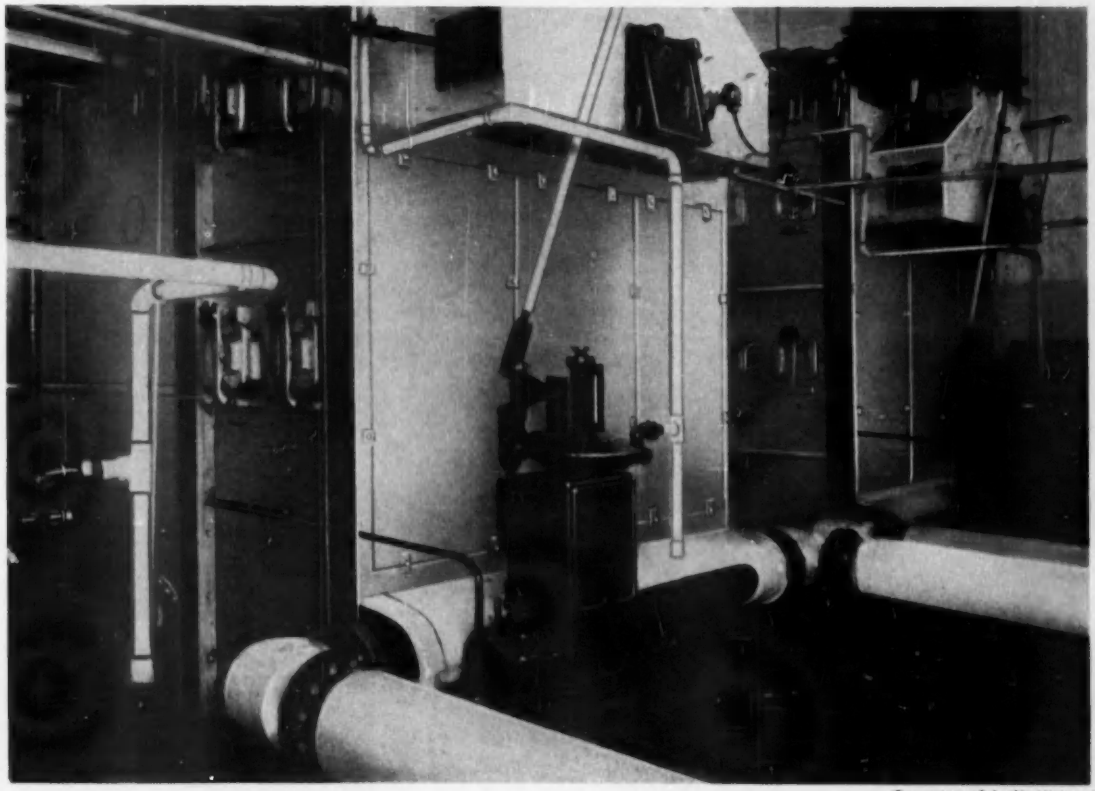

(By courtesy of the Air Ministry.)

Half rear view of two 7-million B.Th.U's/hr. BSF type H.P.H.W. packaged boilers.

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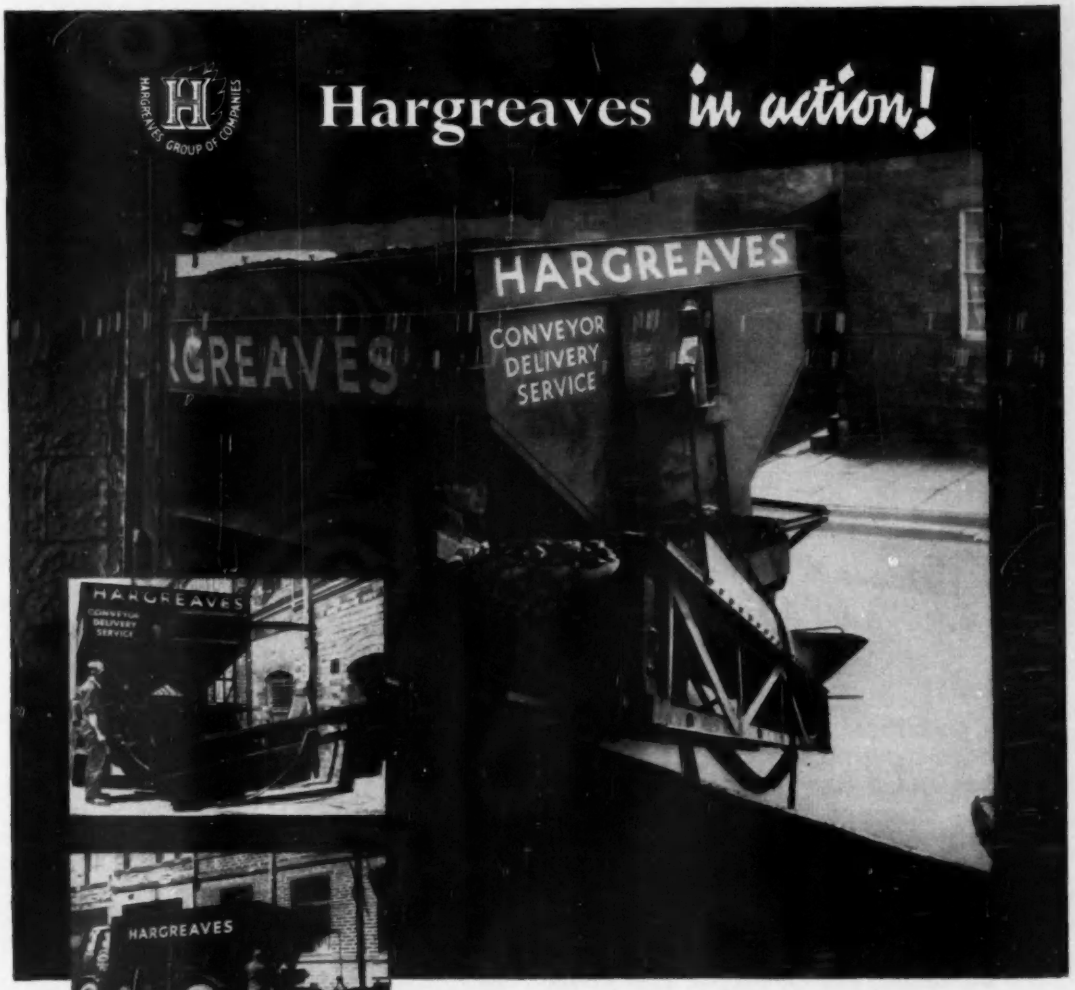

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Engineering and BOILER HOUSE REVIEW

THE OLDEST ESTABLISHED STEAM ENGINEERING PUBLICATION

DECEMBER 1958

VOLUME 73. No. 12

Principal Contents

	Page
EDITORIAL NOTE	385
POINTS AND POINTERS	386
MODERN GEAR AND GEAR UNIT PRODUCTION FACILITIES	388
CASTLE DONINGTON POWER STATION	392
EFFICIENT FUEL UTILISATION	398
550-MW REHEAT BOILER FOR THORPE MARSH	400
SMOKE DENSITY ALARMS AND METERS	404
RECENT EQUIPMENT AND ACCESSORIES	407
OVERSEAS STEAM ENGINEERING PRACTICE	411
LATEST POWER PLANT PATENTS	414
NOTES—PERSONAL AND INDUSTRIAL	418

The Editor will be glad to receive and consider original contributions, correspondence, etc., of a suitable nature for publication. Stamped and addressed envelopes should be enclosed for the return of any matter considered unsuitable

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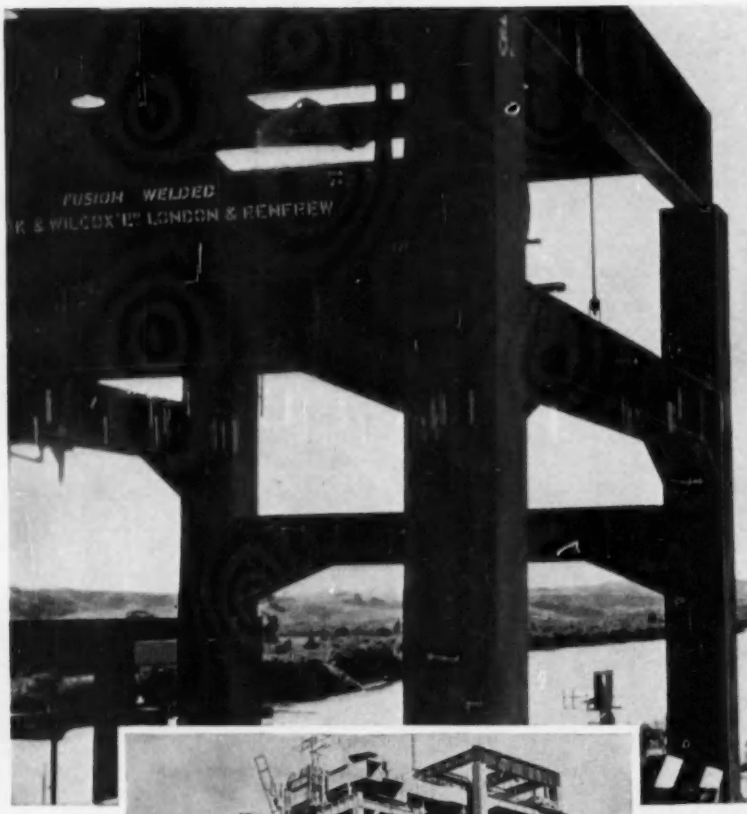

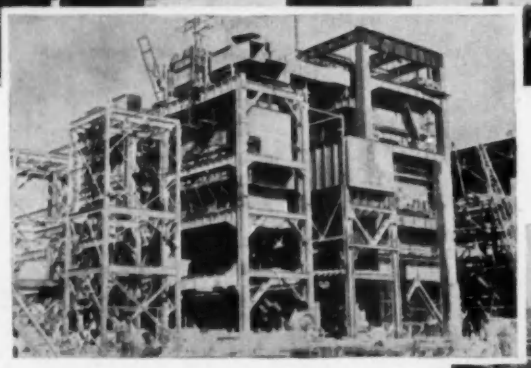

Above and left: Boiler plant during erection at the Mercer power station.

Below: Aerial view of the site on the Waikato river. Fuel will be supplied from the nearby Maramarua coalfield.

In a country where the main source of power is hydro-electric, New Zealand's largest steam power station, now approaching completion near Mercer in the North Island, for the New Zealand Government, is of particular interest.

Being built in one continuous operation, for a capacity of 180 MW, divided between six 30 MW generators, the station is equipped with six Babcock pulverized-fuel-fired Radiant boilers each to supply 300,000 lb./hr. at 635 lb./sq. in., 865°F., in a "semi-outdoor" type installation.

Babcock supplies, in addition to the entire boiler plant, include E-type coal-pulverizing mills, pipework, and the coal, ash and dust-handling plant.

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Engineering and BOILER HOUSE REVIEW

DECEMBER 1958

VOLUME 73 No. 12

THE WORLD'S LARGEST BOILER

IN the historical development of the science and technique of steam generation, there have surely been few advances so epoch-making as the advent of the large-capacity pulverised-fuel-fired boiler unit. Not only has it provided an outlet for the utilisation of the ever increasing quantity of low-grade and almost unsaleable fines formerly dumped at the pit-head, but it has made possible the design and construction of large boiler units of (until recently) nearly 1½ million lb./hr., and now of 3¾ million lb./hr. evaporative capacity. Elsewhere in this issue we publish some general particulars of the 550-MW reheat boiler unit now being constructed by International Combustion Limited for the Central Electricity Generating Board, for installation at Thorpe Marsh power station, near Doncaster.

So far as is known, this boiler is the largest single steam generating unit under construction in the world. The 550-MW generating set which the boiler will steam will also be very much larger than any now in operation, and will have an electrical output greater than the total output from any one of the Board's power stations actually completed and in commission at the present time. Only where there are two or even three individual stations on one site, is there a larger aggregate capacity of generating plant installed. When completed, the Thorpe Marsh station will contain two 550-MW sets, aggregating about 1½ million horse-power; and the furnaces of the two unit boilers will consume approximately 2½ million tons of coal per year. By comparison with a 550,000 lb./hr. boiler unit, the largest only a few years ago, and designed to steam a 60-MW generating set, the Thorpe Marsh boiler will occupy about half the combined space that would be necessary for the several boilers serving a series of 60-MW sets with a comparable aggregate capacity. Furthermore, by incorporating the very latest techniques in design, the capital cost of the boiler will be approximately 65 per cent. of that which would be involved with the requisite number of 550,000 lb./hr. units to give an equivalent total output.

The firing of a boiler of this magnitude is, of course, far beyond the range of the mechanical stoker; in fact, any boiler whose capacity is in excess of 250,000 lb./hr. is actually beyond that range. Thus, the nation owes a great deal to those who pioneered the technique of pulverised-fuel firing little more than thirty years ago. In passing, it may be noted that 64 per cent. of all coal used in C.E.G.B. generating stations is consumed in pulverised-fuel-fired furnaces: the quantity in round figures being 28 million tons a year. Among those to whom credit must be given for this development is International Combustion Limited, whose original pulverised-fuel-fired boiler which was installed in the Manchester area, at the time represented a radical departure from the orthodox designs of the period. These features comprised the use of radiant heat absorption surface as the primary steam generation medium, and the reliance on turbulent combustion to improve heat transfer. These and numerous other characteristics have been retained, although, of course, improved and further developed, to result in the present day design of the Thorpe Marsh unit.

It is of interest to realise that it is only since the end of the second world war that the pulverised-fuel-fired boiler has really achieved a state of pre-eminence. In the early 1930s, it was in keen competition with the stoker-fired boiler, and there was considerable prejudice against pulverised fuel, mainly on the grounds of dust dissemination. This problem has been largely overcome by the introduction of the high-efficiency electrostatic precipitator. In the case of the Thorpe Marsh boiler, the precipitator gas volume will be more than 1½ million cubic feet per minute—a figure which is believed to be the heaviest duty yet proposed for precipitators on a single boiler unit anywhere in the world. Under average conditions, dust will be removed by the precipitator at a rate of about 12 tons an hour.

In such an outstanding example of modern boiler design as the present one, an important feature has been the careful selection of furnace cross-section favourable to effective turbulent combustion; and also the determination of the requisite height to provide adequate radiant heat absorption surface for evaporative needs, and to allow for the accommodation of adequate superheater convection surface. Tilting burners provide means for controlling the proportion of generated heat extracted by each of these major components. The provision of tilting burners also enables steam temperature to be maintained at constant value over long periods, irrespective of the condition of the furnace walls, since burner position can be adjusted to expose, more or less, water-wall surface to direct radiant according to its receptivity.

Points and Pointers

NATIONALISATION From the Federation of British Industries we have received a copy of a report which reviews the arguments advanced for further measures of nationalisation or state ownership of industry, and which sets out reasons for the conclusion that such measures " are not only unjustified but would bring positive harm to the country's economy." The report says that a programme of nationalisation may be examined at two levels ; first, there is the effect on the individual industries selected for the take-over and, secondly, there is the effect on the working of the economic system as a whole. The F.B.I. acknowledges that among individual industries there are exceptional cases where some measure of public ownership or control may have been a reasonable choice. But its report shows that these cases are few in number. Whatever may be thought of the wisdom of past measures of nationalisation, it is asserted, these " exceptional cases " do not in any way bear out the claims for the general superiority of public over private ownership. They belong rather to a narrow zone of industry where public and private ownership are reasonable alternatives and where the balance of advantage may sometimes, though by no means always, fall on the side of the former. For the economy as a whole, the F.B.I. claims, the spread of nationalisation beyond this narrow zone would undermine the foundations of its efficiency. The system of free enterprise has shown, both in this country and in many others, that it provides high and rising standards of living at all levels. Free enterprise, the report states, is an efficient system because it gives men the incentive to seek progress through more efficient ways of doing things ; at the same time it subjects them to the pressures of competition from others who seek the same end. To provide incentives for progress, it is added, there must be a prospect of reward for those who succeed in competition with others. A society which is obsessed by ideas of equality denies these rewards and therefore runs a grave risk of economic stagnation. The report may be obtained (price 5s.) from the Federation of British Industries, 21, Tothill Street, London, S.W.1.

FARADAY HOUSE ENGINEERING COLLEGE Three interesting innovations at Faraday House Engineering College were explained at a Press conference on Thursday, November 6th, by Colonel B. H. Leeson, C.B.E., chairman of the board of governors of the college, and Mr. G. H. Randolph Martin, principal of the college. The first of these changes concerns the award of Diploma Faraday House ; when the academic part of this course has been successfully completed there will be an intermediate award of Graduate Faraday House, G.F.H., which will be followed, on completion of the practical training, by the award of the Diploma Faraday House, D.F.H. This award is intended to cover the broadest field of electrical engineering by similarly broad concepts and study of fundamentals. The second innovation is designed to achieve a somewhat different educational objective by covering fundamentals, with more concentrated study in a particular zone of the whole field of electrical engineering. To meet the second objective, a new award of Associate Faraday House is being introduced next year. It will be awarded for studies in one of the following " zones " of electrical engineering, namely, power engineering, light engineering, telecommunications, electronics. The zonal system is not specialist training, nor does it aim to produce specialists. The training given will be broad within the limits of the zone chosen, and within those limits the student may expect to gain a deeper knowledge than would be expected from the broader D.F.H. training. The third innovation is the reintroduction of an industry-based sandwich course with a sequence of six months' academic work and six months' practical training. This sandwich course will be an alternative to the usual system of a number of academic years (normally three or four, depending on the entry level), followed by a period of practical training, and it will apply equally to diploma and associate students. Very briefly the system is intended to work as follows in the case of industrially based students. An industrial concern will select a number of men having potential ability to benefit from the tuition. Their educational qualifications will determine the entry level into the college, and, therefore, the length of the course. After a year or two years, depending on the entry level, a choice will have to be made between the two objectives—Diploma or Associate. In the case of the industrially based students the choice will be a tripartite one, involving the employer, the student and the principal of the college. A similar choice will be available to the private, as distinct from the industrially based, student, As these important changes are about to be made, it is of interest to recall that Faraday House Engineering College, in association with the Electrical Standardising, Testing and Training Institution Ltd., was established in 1889 with a view to meeting two great needs for the then young electrical industry. These needs were the setting up of a college where sound and systematic training could be afforded for men who desired to enter the industry, and the provision of suitable testing facilities so that the high standard of equipment then envisaged could be maintained. The standardising section of the college ceased to exist when the facilities were no longer needed, having been taken over on a national basis. The college, however, continued and did for a large number of years provide a sandwich system of education, the development and pioneering of which was its sole idea and responsibility. This system consisted of an educational programme which allowed a student to have alternative periods of training in the college and in industrial organisations. For reasons of academic expediency, this system was discontinued about six years ago and the training then instituted in the college consisted of three consecutive academic years, followed by one year's practical training in an industrial organisation.

Thus, the general idea of combining theoretical and practical training was maintained. Earlier this year the Board of Governors was increased numerically, and the Board now consists of Colonel B. H. Leeson (chairman), F. A. Bell (deputy chairman), Sir Josiah Eccles, Sir Vincent de Ferranti, Messrs. T. E. Goldup, S. E. Goodall, J. O. Ince, J. F. R. Ince, Sir Frederick James, Sir Hamish MacLaren, Dr. A. D. Merriman, Sir Gordon Radley, and Mr. L. W. Smith.

FUEL RESEARCH

The report of the Fuel Research Board for 1957 says that, following a careful examination of the present pattern of fuel research in Great Britain, a recommendation has been made that only two main items of research should be transferred from the existing Fuel Research Station, at Greenwich, to the new Warren Spring Laboratory at Stevenage. These are the programmes of work concerned with the measurement and abatement of air pollution and with the synthesis of oil from carbon monoxide and hydrogen which are obtained from the gasification of coal. The report explains how the state of fuel research has changed since the station was established at Greenwich more than forty years ago. At that time there was a need for the station to cover the whole field of research on solid, liquid and gaseous fuels. Since then, however, the pioneer work of the station has led to the growth of other organisations for research on fuels. The intention is that the new laboratory at Stevenage shall be the centre of research in this country on air pollution. Work will be carried out on the reduction of pollution from furnaces or other appliances, on the chemical reactions of pollutants in the atmosphere and on dispersal and convective processes in the atmosphere. The co-operative scheme for the measurement of pollution, together with the collection and analysis of the data, will also be continued. The report goes on to say that this country's dependence on imported petroleum products emphasises the national importance of developing an economic process for converting coal into liquid and gaseous fuels. A few years ago it was difficult to foresee the availability of coal for such a process, but with the rapidly developing use of nuclear energy it is now possible to envisage a future surplus of low-grade coal of the kind now consumed by power stations. Such coal could be converted into liquid fuels and town gas by a combination of gasification and Fischer-Tropsch synthesis. For the synthesis stage the liquid-phase (slurry) technique shows the greatest promise, and work on this kind of synthesis will be continued at Stevenage up to pilot-plant scale. For smoke measurement, it is stated, a small portable instrument, which can be used in place of the Ringelmann chart, is being developed. In principle, the new instrument consists of a small telescope containing a number of translucent screens, darkened to standard shades, with which the smoke can be compared. In one model, two screens corresponding to Ringelmann No. 2 and No. 3 shades are fitted in the body of the telescope and arranged so that they are seen, one above the other, in half of the field of view. The image of the smoke is seen directly in the other half and is in the same plane as the screens. The telescope is held so that the screens are seen against the same background as the smoke. During the last year further research has been carried out on behalf of the Boiler Availability Committee regarding problems of availability of water-tube boilers; particular attention having been paid to the corrosion of low-temperature heat-exchange surfaces, which has become more serious with the use of fuels of high sulphur-content. Also an active part has been taken in several trials at generating stations, in collaboration with the (then) Central Electricity Authority and the British Coal Utilisation Research Association, to investigate the formation of sulphur trioxide in boiler flue gases and methods of inhibiting its corrosive effects.

NEW TECHNOLOGICAL AWARD

In order to encourage qualified persons to undertake further study beyond the level of the Diploma in Technology and carry out original investigations, the National Council for Technological Awards has decided to create an award higher than the Dip. Tech. The intention is that this award shall be a mark of outstanding distinction granted to a student who has proved his ability by completing a substantial programme of work demanding the application of his knowledge to the solution of a problem of value to industry. It is proposed to establish a "College of Technologists," and the new award will take the form of Membership of this College; its short title will thus be M.C.T. To qualify for this new award, a student must undertake a programme of work to be carried out jointly in industry and at a technical college; the programme may be concerned with any technological aspect of industrial activity, such as research, development, design, production or market investigation. The council believes that to carry out successfully post-diploma work of this character, students must remain in contact with industry or with commercial laboratories. Indeed, they are of the opinion that they should not create higher awards which would have the effect of removing a technologist from contact with industry for a considerable period of time immediately after he has gained the Diploma in Technology or an equivalent first qualification. Before starting on such a programme a student must apply to The College of Technologists, through the technical college at which he will study, to be registered as a candidate. The college will consider particularly the qualifications and experience of the student, the suitability of the programme offered and the arrangements to be made for carrying out the work both at the technical college and in industry. The programme offered should be related to the student's personal experience in industry and must have the approval of his employer. The council suggest that a three-year period of work would cover their requirements, provided it can be arranged for a high proportion of a student's time to be devoted to the programme of work proposed. Registration for candidates for the new award will not be restricted to holders of a Diploma in Technology, but may be extended to holders of equivalent qualifications. The student's work must be supervised by a staff member of the technical college at which it is undertaken, and by a staff member of the industrial organisation concerned. The technical college concerned will be responsible for the examination of candidates seeking membership of the College of Technologists while being subject to any general arrangements, including the approval of external examiners, which may be prescribed by The College of Technologists.

Modern Gear and Gear Unit Production Facilities

DUE to the general expansion of the activities of the well-known and old-established engineering organisation of W. H. Allen Sons & Co. Ltd., Bedford, whose range of products includes steam engines, steam turbines, gas turbines, condensing plant, generators, pumps, motors, diesel engines, epicyclic and parallel-shaft gears, etc., a separate works has been established, for the complete manufacture of all the precision gears and epicyclic gear units manufactured by the company. The establishment which is known as Atlas Works, is at Pershore, Worcestershire, and was acquired in 1955. Since then the works have been modernised and re-equipped with new, general-purpose machine tools to work in conjunction with the special gear-cutting machines transferred from the company's works at Bedford. The Atlas Works, in addition to providing a production area of some 50,000 sq. ft., made possible the employment by W. H. Allen Sons & Co. Ltd., of many skilled craftsmen who had previously been employed there, and were thus available. The works re-opening ceremony, was performed on October 24th by Admiral Sir William Tennant, K.C.B., C.B.E., M.V.O., H.M. Lord Lieutenant of Worcestershire.

Two points in connection with the opening of the the new works are worthy of mention here. The first is that at the present time Allen's can call upon over seventy-seven years of specialised experience in the design and construction of complete power-generating plant and pumping plant installations, also electrical machinery applications for every branch of industry and other essential services, as well as for all classes of naval and mercantile marine vessels. The second point of interest is the rather remarkable coincidence that has arisen, in that the Atlas Works at Pershore were founded in the same year, 1880, in which the late W. H. Allen founded his firm in Lambeth, London.

By 1893 the Lambeth works site had become inadequate for further extension and development, and the firm moved to the Queen's Engineering Works, Bedford, where production commenced in 1894. From that time to the present, extensions have been made at frequent intervals to meet the increasing demand for the expanding range of Allen products. Some of the company's production and research activities are also carried out at a subsidiary works, the Biddenham Works, also in Bedford. The gearing department at Queen's Engineering Works was enlarged and re-equipped soon after the second world war, but here also, the capacity of the premises soon proved inadequate, a problem that was accentuated when the company commenced the manufacture of epicyclic gears in addition to speed-reduction gearing of the parallel-shaft type, which up

Fig. 1 (above). A view of the main machine shop at the W. H. Allen Sons & Co. Ltd. Atlas Works, Pershore. Coolant for nearly all these machines is supplied from a central underground chamber containing settling and storage tanks.

Fig. 2 (right). Part of the gear cutting shop. In the foreground can be seen the No. 7 Societe Genevoise jig-boring machine for precision positioning of the holes for the planet-wheel spindles in planet carriers of Allen-Stoeckicht epicyclic gears.

to that time had been made in considerable numbers for use with Allen steam-turbine generating sets. Epicyclic gearing made by the company is produced under a licence and design consultancy agreement with Dipl.Ing. W. Stoeckicht of Munich.

The main buildings of the Atlas Works were originally arranged as a cruciform, which has proved a most suitable layout for a gearing production establishment, with the works offices, inspection, tool stores and finished parts stores situated in the centre of the cruciform, a position which allows for efficient control of the works. The arm of the cruciform running from east to west comprises the main machine shop for general-purpose machining, with the inwards stores and despatch department situated at the east end. Heavy machines are concentrated under a main overhead crane which runs along the centre of the shop, and the lighter machine tools are installed in the side aisles where the roof height is lower. The gear parts produced on these machines are handled by electrical hoists. Situated towards the eastern end of the cruciform are large horizontal borers together with a 100-in. Lumsden surface grinder, which is used to surface the joint faces of all gear cases. Other general-purpose machine tools include centre-lathes, capstans, milling machines, internal and external grinding machines and precision boring machines. Two electro-magnetic Avery dynamic balancing machines are also installed and are capable of balancing components weighing up to 6,000-lb. An electric annealing furnace is installed at the east end of the shop for stress relieving components between machining operations, and can handle components up to 4-ft. cube, the temperature and time cycle being automatically controlled.

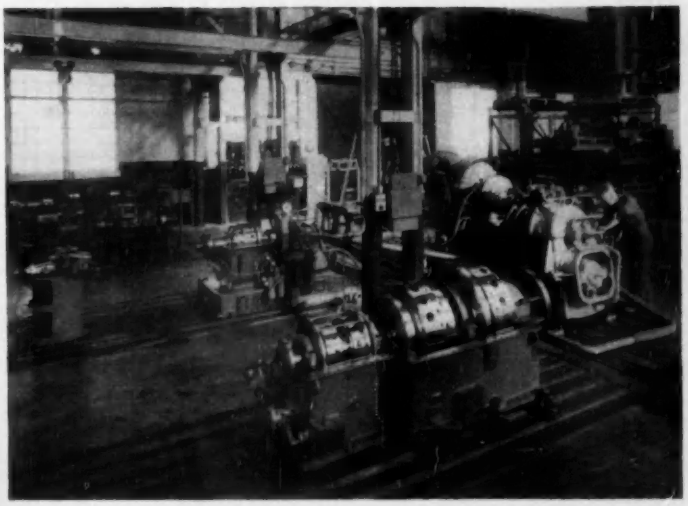


Fig. 3 (left). The 72-in. David Brown-Muir gear-hobbing machine, which is capable of producing gears to Grade A accuracy.

Fig. 4 (above). View of a section of the test-bay, showing some epicyclic gear units, including a main propulsion reverse reduction gear, assembled for testing.

The gear-cutting shop is situated in the southern arm of the cruciform, in which are installed all the gear-cutting and finishing machines, together with a No. 7 Societe Genevoise jig-boring machine. The largest gear-hobbing machine is a 72-in. David Brown-Muir machine, capable of producing gears to Grade A accuracy. Most of the hardened components made are shaved before nitriding, with no subsequent process to the profiles of the teeth, but in some cases, components which have been carburised and hardened, are subsequently ground on Maag machines. The two Sykes 3C shaping machines installed were specially built to W. H. Allen Sons & Company's own specifications. All gear-tooth components are thoroughly inspected in a part of the gear shop which is well equipped with special measuring machines, including two Maag PH.60 machines, and a No. 2 and No. 4 Goulder gear checker.

The northern arm of the cruciform is laid out as the fitting, assembly and testing shops, and adjacent to this shop is the finished parts stores. In the testing area, a Ward-Leonard control-system is used in conjunction with d.c. motors to provide variable-speed running conditions, and also there is a small high-speed water-brake for light-load tests. The nitriding plant installed is capable of nitriding wheels up to 20-in. pitch circle diameter, and although this may not appear very large, it is envisaged that the plant will meet the requirements for many gears capable of transmitting powers up to 20,000 h.p. Also in the shop are facilities for the white-metal-lining and facing of all bearings and planet-wheel spindles. Although it is unusual for white metal to be applied to the outside of a spindle, special techniques have been developed for this treatment.

Epicyclic gearing

The essential difference between the epicyclic and conventional parallel-shaft gear is that, in the ordinary train, the axes of the wheels are fixed, but in an epicyclic train at least one axis moves around another axis which is fixed.

In recent years considerable progress has been made in the development and utilisation of epicyclic gearing. Whereas formerly the parallel-shaft design of gear was

employed in various industrial and marine-type machinery installations, the success of epicyclic gearing has led to its increasing adoption for many applications for the transmission of a very wide range of powers at varying speed ratios. It is extensively used for both speed-reduction and speed-increasing drives, notably in the former case in conjunction with steam and gas turbine-driven generators. Of the large number of gear units now produced by W. H. Allen Sons & Co. Ltd., for powers up to 15,000 h.p. and speeds up to 33,000 r.p.m., the majority are of the epicyclic design, and experience has proved that this design of gear, with its reliability, high efficiency, quiet and smooth running, low weight and small dimensions, offers the most compact speed-reduction or speed-increasing unit for most applications. In the past, epicyclic gears were of the spur or single-helical design, but to-day an improved patented design of double-helical gear is available and can be offered as standard practice.

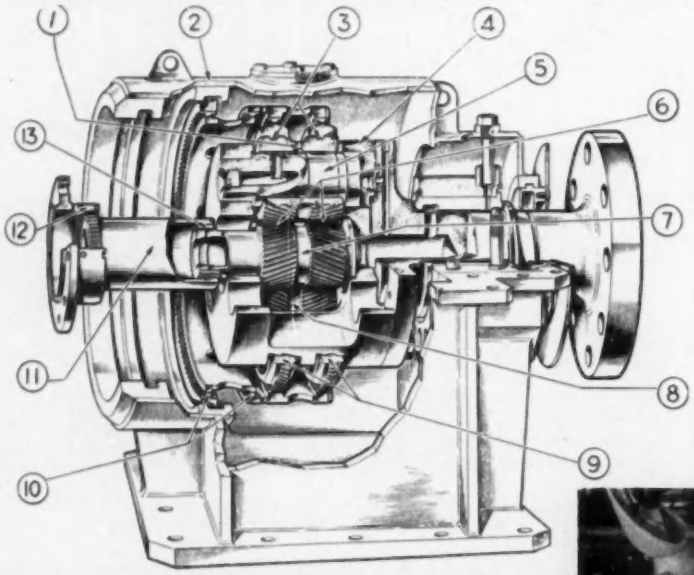


Fig. 5 (left). Cut-away drawing showing assembly of component parts of a typical Allen-Stoeckicht patented double-helical epicyclic gear unit.

KEY:—1—Planet wheel; 2—Casing; 3—Annulus/planet-wheel contact; 4—Planet carrier; 5—Planet-wheel spindle; 6—Sun-wheel/planet-wheel contact; 7—Sun wheel; 8—Planet wheel; 9—Annulus (double); 10—Double gear-tooth-type coupling; 11—Coupling sleeve; 12—Internally-toothed coupling flange; 13—Sun-wheel coupling teeth.

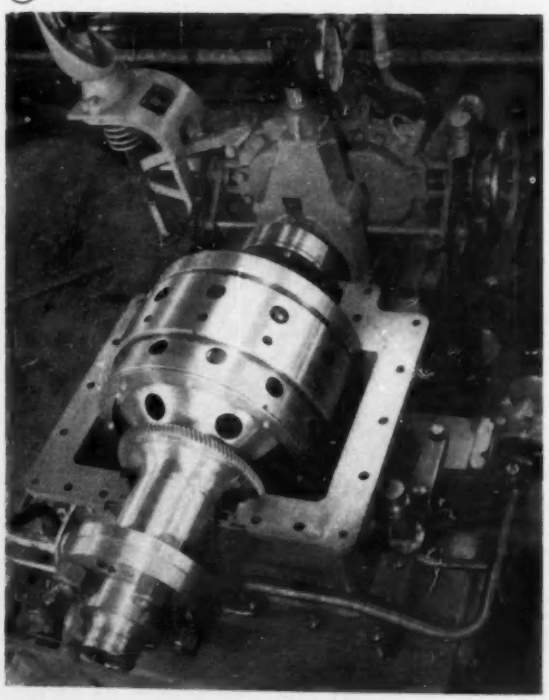
The rapid growth in the use of this double-helical design in Europe can be judged by the fact that in 1951 there were comparatively few applications and the total horse-power involved was small. By the early part of 1958, however, the number of applications had increased to 1,500, transmitting a total of 3-million h.p. This is an average of 2,000 h.p. for each gear, but in fact, the actual ratings vary from about 100 to over 10,000 h.p. The gears provide a wide range of input speeds, varying from a few revolutions per minute up to 45,000 r.p.m.

As in the case of other types of Allen products, epicyclic gear units are specially designed and built to meet individual requirements and to suit all types of prime movers and/or driven machinery.

Amongst the many advantages of the epicyclic gear, it should be borne in mind that the weight and space requirements of the gear proper are very considerably reduced, compared with those required by conventional gears for the same life expectation and factors of safety—whilst the absence of transverse forces on either the input or output shaft eliminates the need for high-speed pinion bearings. The pinion is supported by the planet wheels and connected to the high-speed shaft by means of a double gear-tooth-type coupling. Again, if the driven member already has two bearings of its own, e.g., a generator or a pump, the planet carrier may be over-hung, with no additional low-speed bearing. These savings in bearings facilitate erection and alignment and also result in lower bearing power losses; the planet bearing losses in an epicyclic gear are normally much less than the sum of the pinion and low-speed bearing power losses of the equivalent parallel-shaft gear. Consequently, less oil is needed and a smaller oil cooler may be used.

Of particular interest, and as an example of an application in the field of steam raising, our illustration, Fig. 6,

Fig. 6 (below). An epicyclic speed-increasing gear for a 2,400-h.p. motor-driven boiler-feed pump, assembled for testing at the Atlas Works. The speed increase is 1,500/4,500 r.p.m.



shows an epicyclic gear for use with a motor-driven boiler-feed pump. This is a speed-increasing gear designed for transmitting 2,400-h.p. from the motor speed of 1,500-r.p.m. to the pump speed of 4,500-r.p.m. The gear is interesting in that it has no main bearings. The rotating annulus assembly, which forms the low-speed shaft, is connected direct to the motor shaft. The high-speed sun wheel is supported between the three planet wheels and is coupled direct to the pump shaft through a gear-tooth-type flexible coupling. This arrangement of gearing eliminates the use of external flexible couplings.

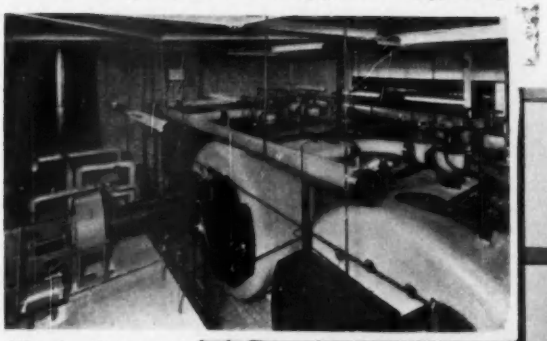
Other gears of the design referred to in connection with boiler-feed pump drives are being manufactured for compressor and blower drives. One at present in an advanced stage of manufacture is for an 11,000 h.p. motor-driven centrifugal compressor plant installation in Canada. In this instance the internal components of the gear are so designed that they will be mounted in the pedestal supporting the motor/compressor bearings.

In conformity with the modern trend towards higher powers in many different machinery applications, plans are already in hand for the installation at the Pershore Works of larger general-purpose machine tools and gear-cutting machines for the continued development and greater production of epicyclic gearing.

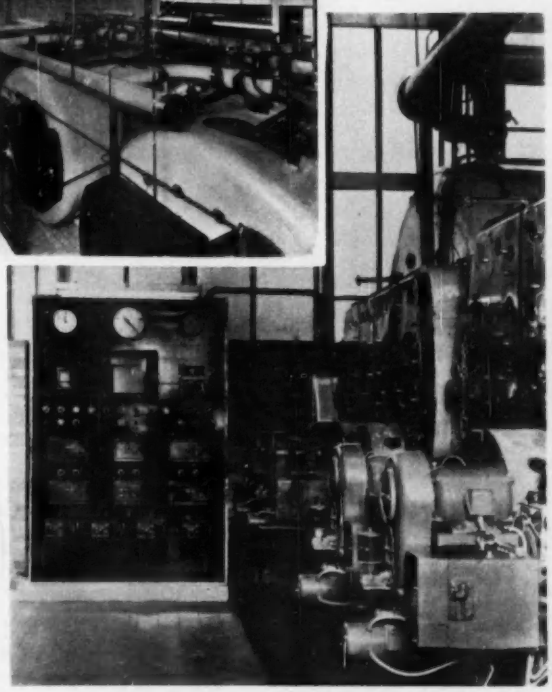
The number of people employed at the Atlas Works at the present time is around 220, of which total only a small nucleus of skilled personnel and technical staff were transferred from Queen's Works, Bedford. In addition to the production side, the complete design and sales activities of the Allen gearing organisation are centred on Atlas Works, but the accounting and associated functions continue to be handled at Bedford.

A NEW CENTRAL BOILER PLANT INSTALLATION

When a new office block, and works extensions, were planned for George Mann & Co. Ltd., one of the largest manufacturers of lithographic off-set presses in the world, it was decided also to install a central boiler plant to supply all the space-heating requirements. Consultants for this latter undertaking were Brandt and O'Dell, of London, while the actual installation work was carried out by Pearsons (Installations) Ltd., Leeds. A survey by the consultants indicated that, allowing for a margin of approximately 25 per cent., the total heating load would be 18,640,000 B.Th.U./hr., and to provide this two 10-ft. by 13-ft. 6-in. "Thermax" boilers, supplied by Ruston & Hornsby Ltd., were installed. These units are of the fully-flooded type, designed to operate in conjunction with nitrogen pressurisation equipment, which can cater for a maximum flow temperature of 250 deg. F., a maximum return temperature of 180 deg. F., and a working pressure of 50 lb./sq. in.



(Above). Rear view of the boilers in the office and works extension of George Mann & Co. Ltd.



(Right). The fronts of the two "Thermax" boilers supplied by Ruston & Hornsby Ltd. The oil-burners were made and supplied by Hamworthy Engineering Ltd.

Each "Thermax" boiler is provided with two rotary oil burners supplied by Hamworthy Engineering Ltd., and suitable for operation with 3,500 sec. fuel oil. The burners are controlled by an outside compensator to suit external air conditions, and the oil fuel is drawn from a storage tank, 15-ft. dia. by 21-ft. high, through a hot-water heater, or alternatively an electric heater—each being capable of handling 225-gal./hr. The oil supply pipes have been fitted with electrical tracer lines which maintain the fuel at a maximum temperature of 160 deg. F.

Extremely compact installations are possible with this type of unit, as can be seen from the accompanying illustrations, one of which shows the induced-draught fans mounted on top of a brick flue at the rear of the boilers. Beyond these fans are the hot-water and electric oil heaters which are arranged on top of the flue in a particularly accessible position, thus ensuring ease of maintenance. The brick flue connects to a 70-ft. high by 4-ft. 6-in. dia. chimney which incorporates a draught stabiliser. The actual heating system within the works comprises radiant heating panels, while the new office block is heated by a low-temperature hot-water system using concealed connectors together with ceiling heating in the entrance hall. It is estimated that the new plant will operate at an efficiency of 80 per cent., compared with a figure of 55 per cent. for the original installation, while the actual cost of the new centralised boiler plant will be recovered by savings in fuel and running costs within five years.

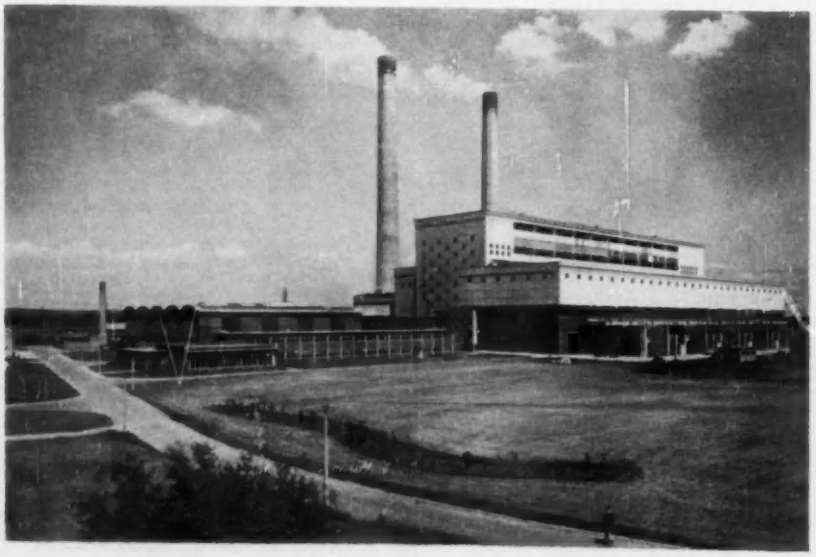
In the face of strong international competition, **The Harland Engineering Co. Ltd.**, Alloa, Scotland, have received a valuable dollar earning contract for the water turbines and governors to be installed in the new power station now being constructed in the Elburz Mountains near Teheran, Iran, for the Karadj Dam Authority, by Morrison-Knudsen International Constructors, Inc. and their consulting engineers, Harza Engineering Company International. The "Harland-Morgan Smith" vertical Francis water-turbines to be installed in 1960, are rated at 56,000 b.h.p. under 482-ft. net head at 333 r.p.m., and each is capable of producing approximately 80,000 b.h.p. under maximum head conditions. Special features in the design of the turbines will be made to meet a very wide head range. Power from the station, which is designed to receive three generating sets, will be transmitted to Teheran approximately 29 miles away. The plant will be manufactured and tested in the Harland Works at Alloa.

Castle Donington Power Station

Since we published in the April 1957 issue of this journal, an illustrated description of the station, considerable progress has taken place in the construction and commissioning of further plant. Of the ultimate six 100MW boiler/turbo-alternator unit sets, five are in commission, and the sixth is to follow early next year. Three of the sets supply the 132-kV network, while the remaining three are connected to the 275-kV supergrid. For the past two years, Castle Donington has headed the list of the highest thermal efficiencies achieved by the steam power stations of the C.E.G.B.

CASTLE DONINGTON power station, which was officially opened on October 22nd, by Col. Lord Cromwell, D.S.O., M.C., J.P., Lord Lieutenant of Leicestershire, is situated in the East Midlands Division of the Central Electricity Generating Board, on a 190-acre site on the south bank of the River Trent, about seven miles south-west of Derby. It is the first station in this country to operate single boiler/turbo-alternator units of 100-MW rating. Upon the formation of the (then) British Electricity Authority in 1948, it became possible, for the first time in the history of the electricity supply industry in this country, to co-ordinate the pattern of electricity generation with the pattern of coal production on a national scale. In view of the rapid expansion of supplies of steam-raising coals from the East Midlands coalfield, it was planned to locate along the banks of the Trent (which is the nearest source of cooling-water supply to this coalfield), a number of the new and large power stations which were required to increase the generating capacity of the country. The output from the chain of power stations would serve not only the load centres in the Mid-England area, but part of the energy generated would be transmitted over the new 275-kV Supergrid system to load centres in the south of the country where there is a deficiency of coal supply. One of the sites selected for development was that at Castle Donington. Representing perhaps the biggest single step forward in power generation technique at the time of its conception, Castle Donington is noteworthy on account of the increased capacity of its boiler/turbine units, the omission of spare boiler capacity, and the advanced steam conditions prevailing when construction commenced in 1951. Economy in the design, or rather construction of the station buildings is reflected in the use of less expensive and lightweight cladding materials in place of conventional brickwork.

The six Babcock & Wilcox boilers represented, at the time of their design and construction, a logical development of the Radiant principle, and, apart from their outstanding size, their evaporative capacity (830,000 lb./hr.) is still about one-and-a-half times that of any boiler at present in commission in this country. In fact, they are believed to be still the largest boilers in service in Europe at the present time. With a feedwater temperature of 400 deg. F., the steam conditions at the superheater outlet are 1,600 lb./sq. in. and 1,060 deg. F. Other noteworthy features of these boilers are the twin furnaces, with their dividing screen of tangent bare water-tubes, the use of burner selection for course control of steam temperature, and the provision of an auxiliary primary-air heater to facilitate the handling of wet coal. The combustion chamber volume for each boiler unit is 71,500 cu. ft. Each single-drum unit comprises radiant boiler heating surface (boiler tubes 3,600 sq. ft. heating surface), primary superheater (39,700 sq. ft. heating surface), secondary superheater (16,420 sq. ft. heating surface), Babcock & Wilcox multi-loop type economiser 32,600 sq. ft. heating surface, and two Ljungström rotary regenerative type air-heaters supplied by James Howden & Co. Ltd., each of 139,000 sq. ft. heating surface. These air-heaters are designed to reduce the outlet flue gas temperature to 265 deg. F., and supply combustion air to the furnace at a temperature of 445 deg. F. The boilers are suspended from the main structural steelwork of the boiler house, the weight of each complete boiler unit being approximately 1,900 tons; the total load carried on each of the building sup-

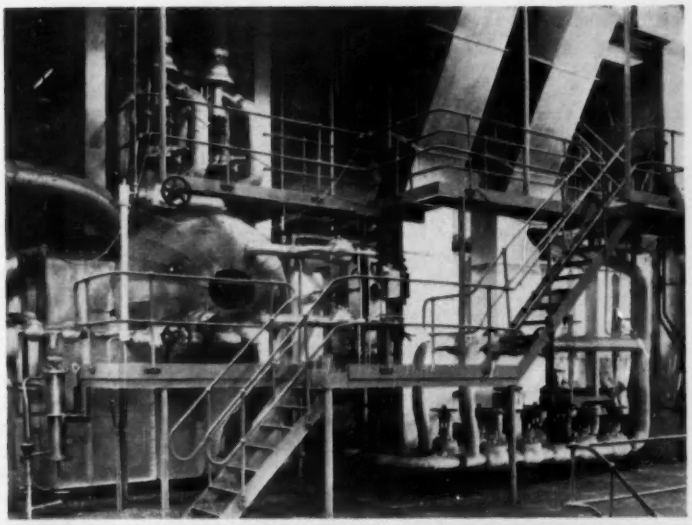


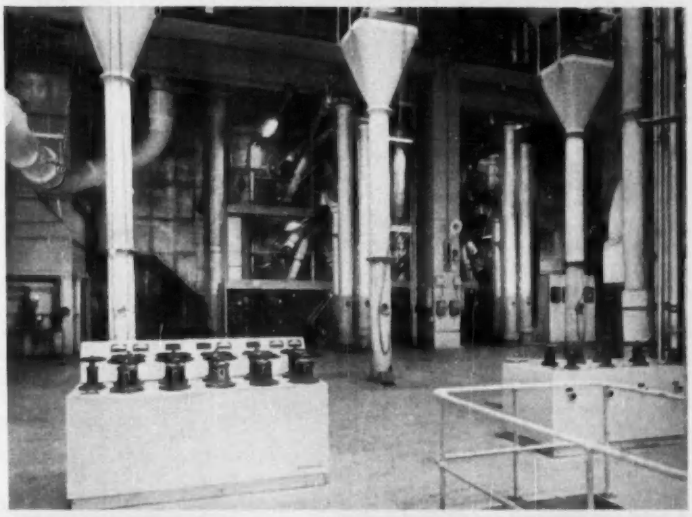
View of station looking from a south-westerly direction.

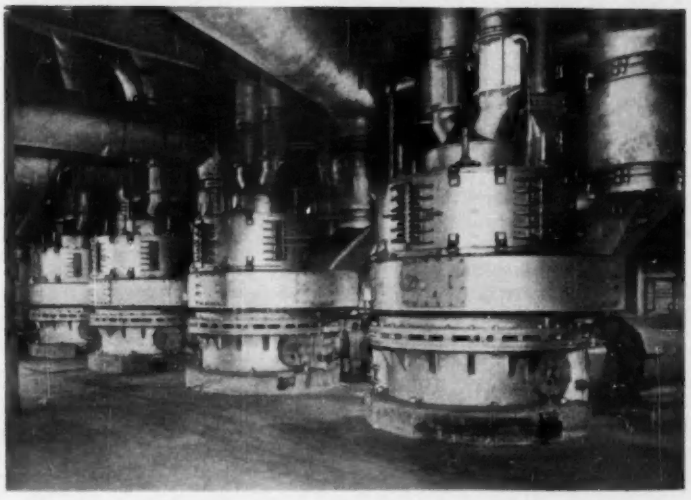
(Top). View at drum level of No. 1 boiler unit. The centre-line of the drum is 123-ft. above base-ment level.

(Centre). View at operating-floor level of No. 1 boiler unit showing fuel pipes and p.f. burners.

(Bottom). There are five Babcock & Wilcox 13-ton/hr. type-E70 pulverised-fuel mills each with its associated primary-air fan for each boiler.







porting columns being 1,407 tons. Thus, separate boiler structural steelwork, such as that used in older stations, is unnecessary. The boiler bunkers are designed on the stressed-skin principle and are believed to be the lightest in weight of steel yet built in relation to the weight of coal carried (1,000 tons per boiler). The roof of the main building is of lightweight steel decking and provided with skylights. Throughout the building design the keynote lay on simplicity and maximum economy in the use of steel. The two reinforced-concrete chimneys which were built by J. L. Keir Ltd., are 425-ft. high and are supported on concrete rafts each with 209 bored concrete piles 19-in. dia. The total weight of each chimney and the foundations is 8,200 tons. In view of the height of these chimneys, a special and independent aerodynamic research was carried out to determine the design features. As a result, it was found that unless the chimneys had circular exterior surfaces, there would be a danger of resonant oscillation at wind speeds in excess of 60 miles per hour. The internal dia. at the chimney top is 23-ft.

Coal-handling plant

The coal-handling plant, which was designed and supplied by Babcock & Wilcox Ltd., has many interesting features, and is one of the largest in the country. Coal is transported to the site in rail wagons and is shunted on the station sidings by diesel or steam-driven shunting locomotives. Groups of wagons are shunted to the side-tipping wagon-tipplers where they are emptied and moved off by electric capstans. The empty wagons are then marshalled into trains for returning to the collieries. The coal-handling plant comprises four Babcock & Wilcox side-tipping wagon tipplers, which are fitted with automatic doors and dust-exhausters to prevent dust nuisance, and discharge into hoppers and on to belt conveyors. The belt conveyors then transport the coal either to the boiler bunkers or to the coal storage area. Electro-magnetic vibrating feeders

and coarse coal crushing equipment are incorporated in the belt train. The plant is designed to handle standard railway wagons of capacities up to 24½ tons, the tipplers being capable of delivering coal at the rate of 180 tons per hour, when handling wagons of 12½ tons capacity. Coal can be delivered to the bunkers at the rate of 960 tons per hour either from the tipplers or reclaiming from the coal store. The coal is stocked out or reclaimed from the storage area by belt conveyors, each approximately 2,000 ft. long, running the full length of the area, working in conjunction with a travelling transporter and hopper for reclaiming purposes and an automatic belt tripper for stocking-out purposes. Practically all the driving motors associated with the coal-handling plant were supplied by Lancashire Dynamo & Crypto Ltd.—the total horse power of the motors being about 1,600. All the motors are fitted with hydraulic couplings supplied by Fluidrive Engineering Co. Ltd. These couplings, of which there are nearly forty, are standard traction-type units ranging from 18 to 130 h.p. Five Babcock & Wilcox pressure-type (E.70) pulversing mills, each with its associated primary-air fan, are provided for each boiler furnace. The maximum capacity of each mill is 13 ton/hr. Four of the mills can maintain the maximum boiler load with normal fuel supplies. The mill motors were made and supplied by Lancashire Dynamo & Crypto Ltd., and each of 150 b.h.p., 3,300 V, and operate at a speed of 590 r.p.m. The Howden primary-air fans serving the mills, and which draw air from the F.D. ducting via the primary air-heaters are also driven by Lancashire Dynamo squirrel-cage motors of 195 h.p., through flexible couplings at 1,480 r.p.m. The mill sealing-air fans were supplied by Keith Blackman Ltd. From the mills, the pulverised coal is conveyed to the twenty 11-in. horizontal circular type B. & W. burners fitted in the front furnace wall of each boiler. In addition, each furnace is fitted with twelve Babcock pressure-atomising oil-burners with automatic low-tension spark ignition. These oil-burners are capable of carrying 10 per cent. of the maximum boiler load. Each boiler has two forced-draught, and two induced-draught fans—all supplied by James Howden & Co. Ltd., and driven by Lancashire Dynamo & Crypto motors. The 328 h.p. F.D. fan motors are of the totally-enclosed "Corcooled" type, and have endshield-mounted spherically-seated self-oiling sleeve bearings, and operate from a 3.3 kV, 50 c/s, 3-phase supply.

The electrostatic precipitators, of which there are twelve, and therefore two per boiler, were supplied by Sturtevant Engineering Co. Ltd. These precipitators are of large size—the throughput of each half unit being 232,500 cu. ft./min. at 290 deg. F., and with 11 per cent. CO_2. The guaranteed efficiency of the precipitators is 96 per cent. at the design loading. The high-tension sets are paired in suitable high-tension houses, and interconnected on the output side so that either h.t. set can operate on either or both precipitators serving each boiler during periods of maintenance or overhaul. Special precautions have been taken to guard against possible corrosion of the precipitator casings, which are provided with double-sided inlet flues.

Gases from the precipitators are exhausted by means of the induced-draught fans (two per boiler) into the two chimneys, which are connected together and to the fan outlets by a main flue, fitted, of course, with the requisite dampers. The i.d. fans were supplied by James Howden & Co. Ltd., and are of the double-box-inlet type, two-speed with vane control. The duty volume of each fan is 240,000 cu. ft./min., at 16-in. w.g. at a temperature of 270 deg. F., and the speed 585/735 r.p.m. Each fan is driven by a two-speed motor, 833 h.p. at 735 r.p.m., and 455 h.p. at 585 r.p.m. These fan motors, which are of the totally-enclosed, closed air-circuit type with water-cooled air-coolers, are mounted on specially deep bedplates. They were supplied by Lancashire Dynamo & Crypto Ltd., and have separate pedestal, spherically-seated self-oiling sleeve bearings. For protection against condensation, internal heaters are fitted which come into operation when the motors are switched off. These heaters maintain the internal temperature of the motor 5 deg. above the surrounding atmosphere.

Boiler insulation

The thermal insulation of the six boilers, including that for the integral piping, the feed and blow-down piping, and also the main steam piping between boilers and turbines, was carried out by The Darlington Insulation Co. Ltd. The well-known 85 per cent. magnesia products of the firm's associated manufacturing company, The Chemical & Insulating Co. Ltd., were used. These included Dextramite high-temperature preformed sections suitable for use up to 1,800 deg. F., and Armouring Compound No. 1 which is now being widely used throughout industry to provide a hard surface finish which is water repellent and does not crack on drying. This material was used as a final finish on piping and other items within the boiler casings. The boiler furnace finish, except where Armouring Compound No. 1 was used, comprises the company's special hard setting composition. Protection plates are fitted at floor levels to prevent damage to the insulation, and this work was carried out by S. T. Taylor & Sons Ltd., a member firm of the Darlington Group of Companies.

The thermal insulation work on the boiler outlet-flues, main flues, air-heater ducting, gas flues, hot-air ducting, hoppers and fans, was carried out by Versil Ltd. The insulation consists entirely of Versil glass-fibre block mattresses of various thicknesses, finished on all flat surfaces with asbestos hardboard secured with mild-steel channel banding held in position with cruciforms, triforms, biforms and special corner pieces. On circular ducts the insulation is finished with reinforced armouring cement. On all insulation out in the open, the insulation is held in position with expanded metal secured by means of steel rods threaded through special cleats, supercoated with reinforced armouring cement, and waterproofed with emulsified asphalt.

As a protective coating the boilers are treated with "Rapidal 312" heat-resisting aluminium and omnium gloss paint, supplied by Griffiths Bros. & Co., London Ltd., Wednesfield, Staffs.

Instrumentation and control

Each pair of boiler/turbine units is controlled from a central plant control room, located between the turbine house and boiler house at the operating floor level. There is no dividing wall between the boiler and turbine houses. All the instruments for the automatic control equipment are located in this room, together with remote-controls for auxiliary motors, turbine supervisory equipment and alarm systems. All the boiler and turbine

control panels were supplied by Bailey Meters & Controls Ltd., who were also the main contractors for the instrument equipment.

Those instruments and controls not required for the constant operation of the sets are located adjacent to the associated plant items. A comprehensive telecommunication system connects the plant control room with operators at different levels in the boiler house, turbine house, coal and ash plant houses, as well as providing direct communication with the main control room.

Damper control equipment

Lockheed centralised hydraulic damper controls are employed for the complete boiler plant, and afford power operation with manual standby for a total of sixteen points, of which six are electro-hydraulically operated and include provision for automatic closing. Manually-operated selector valves are mounted on the control panel, and these have ten ways, affording power control for dampers controlling air-heater air-bypass, and air outlet, primary air-heater gas inlet and gas outlet and air to primary air-heater, two selector ways being used for each. Isolating or " limit " indication by means of edgewise indicator light units is provided for the two last-named points, while the remainder have " regulating " indication, with edgewise form indicators in which the usual pointer moves over a divided scale to show the exact degree of opening. Operation of any of those ten points is obtained by raising the appropriate selector valve lever and then moving the metering and reversing valve control handle in the direction required to give the desired—opening or closing—damper movement. The other six selector valves are of the electro-hydraulic type and are employed for control of the air-heater gas inlet and the i.d. and f.d. fan discharge dampers, all of which are provided with isolating indication light units on the control panel. The use of the electro-hydraulic method of operation for these dampers enables automatic closing in the event of fan motor stoppage to be incorporated. The dampers are automatically closed, eliminating the chance of blow-back, whether the stoppage of the fan motor is due to electrical failure or to inadvertent switching off. An additional interesting feature is that this automatic closing is given priority over all other damper operation, whenever the need arises, and a solenoid-operated valve is employed to render the other controls momentarily non-responsive.

The control panel is furnished with " open " and " close " push buttons for the electro-hydraulic selector valves and a noteworthy detail is that, because of the automatic closing, certain dampers, as deemed necessary, cannot be re-opened until the appropriate fan motors are re-started. A further interesting detail is that a two-way restrictor unit is provided and enables speed of operation for the ten damper-operating cylinders, which are controlled via the manually-operated selector valves, to be set at a suitable optimum for the convenience of the operator, facilitating accurate control of the " regulating " dampers. A " pump pressure " indicator light is mounted on the control panel and, if this fails to light up when automatic closing of a damper should be taking place, the operator is warned that fluid pressure must be provided by turning the handwheel of the panel-mounted manual-hydraulic transmitter in the " closing " direction.

Ash and dust disposal

The Babcock & Wilcox Hydrojet and Hydrovac systems are installed for ash and dust disposal respectively. Each boiler has a twin-type (2 × 27 ton) water-filled ash-hopper from which coarse ash is discharged via high velocity sluices to ash sumps, from which it is removed by grabbing crane to a drainage apron where the surplus water with fine ash is drained off to the dust sumps, and the drained coarse ash is grabbed into lorries for removal. For each boiler there are twelve precipitator dust-hoppers from which the dust is ejected by high-pressure water jet; the dust from the boiler and chimney hoppers is removed by Babcock & Wilcox Hydrovactors via windswept dust-valves fitted with automatic vacuum breaker valves. The dust slurry is sluiced to the dust sump from where it is pumped to the dust disposal pits situated some two miles N.E. of the station. The estimated ash and dust make per annum from the completed station is 307,800 tons:—

The turbine house, showing four of the five Metropolitan-Vickers 100-MW turbo-alternator sets commissioned. The sixth set is due to be commissioned during April of next year.

viz., 277,000 tons of dust and 30,800 tons of ash. The area of the initial disposal lagoon (old gravel pit workings) is approximately 58 acres, with an estimated capacity of 703,000 tons and an expected "life" of five years from the date of commissioning the first unit.

Turbo-alternator plant

The six 100-MW turbo-alternator sets, each complete with its own surface condensing and feed-heating plant, were designed and supplied by Metropolitan-Vickers Electrical Co. Ltd. The turbines are of two-cylinder construction, running at 3,000 r.p.m., and operating with inlet steam conditions of 1,500 lb./sq. in. and 1,050 deg. F. The generators, to which the turbines are direct coupled, have a generating voltage of 13.8-kV; they are hydrogen-cooled, and are generally similar in design to other Metropolitan-Vickers machines of that type. A notable feature of the complete unit is the relatively low overall length of 80-ft.; this has been achieved by the use of a rigid coupling between the high-pressure and low-pressure rotors, with only one central bearing and a single thrust block to locate the combined rotor.

Turbovisory gear is provided to observe and record h.p. shaft eccentricity, differential expansion between the h.p. turbine rotor and cylinder, and shaft speed. The following values are also recorded:—load, total expansion, also steam and metal temperatures. This equipment enables the operator to run the machine up to speed and apply load with safety, within a minimum time without exceeding the permissible limits. The steam from the double-flow exhaust of the turbine low-pressure cylinder passes into twin two-pass condensers which have a total cooling surface area of 80,000 sq. ft., and require 64,000 gal./min. of cooling water.

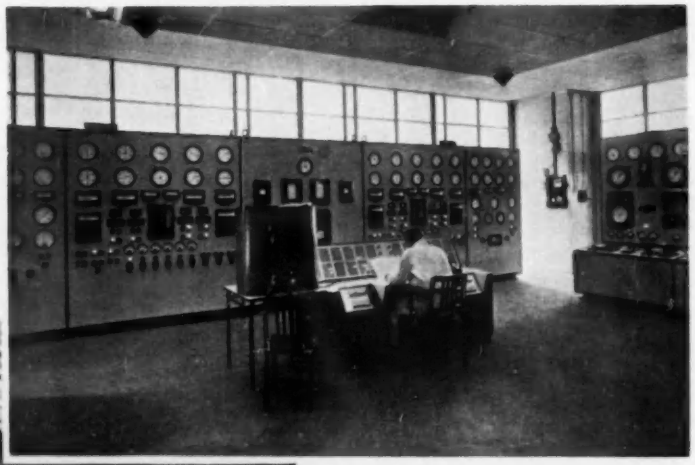
The insulation work on the turbine casings and all ancillary equipment such as evaporators, de-aerators, high-pressure and low-pressure integral piping connected with the complete circulation was carried out by Newalls Insulation Co. Ltd. The materials used were Newalls "Newtempheit" plastic and Magnesia plastic, the finish being carried out in hard-setting composition, finally wrapped with white cotton canvas.

Water-treatment plant

The water supply to the evaporators is obtained from shallow wells on the site, and is first passed through a fully-automatic hydrogen ion/sodium zeolite water-treatment plant and a mixed-bed Deminrolit plant, all supplied and installed by The Permutit Ltd. The HI/Na blend plant was designed in two identical sections to provide greater flexibility to flow control. Each section is designed to produce 180,000 gal. of treated water per 24-hour day. Raw water entering either section of the HI/Na blend plant is passed to one of the HI units. These units contain cation exchange material which works on the hydrogen cycle so that mineral salts in the raw water are converted to their corresponding acids, and bicarbonates are decomposed to form carbon dioxide and water. In a similar way, the Na units are fed with raw water and the calcium and magnesium salts formed are converted to their sodium equivalents. The HI water treated by the HI units and Na units is then blended so that the acids in HI treated water are neutralised by the alkalinity present in the Na treated water, resulting in further liberation of carbon dioxide and residual alkalinity dependent on the proportion of base-exchange treated water.

The transportable mixed-bed Deminrolit unit provides demineralised water for boiler feed purposes. It is fed with water from the HI/Na blend plant and is designed to produce 3,800 gal./hr. of treated water, sensibly free from dissolved solids and with an electrical conductivity of the order of less than 1 reciprocal megohm per cu. cm.

(Left). Control room on the boiler/turbine operating floor. There is a control room for each pair of boiler/turbine units.



(Below). Main station control room, showing (on left) part of the 275-kV board, and (on right) one of the 132-kV boards.

This unit contains a mixture of anion and cation exchange materials and is manually-operated. Comprehensive regeneration equipment is provided, and the end point of the treatment run is detected by a Permutit type-DT3 conductivity tester.

Cooling-water system

The cooling-water supply is obtained from the River Trent (which has a minimum average summer flow of 8.5 million gal./hr.), the water being drawn from the river by six river pumps, supplied by Worthington-Simpson Ltd. After passing through fixed coarse screens, and then through six travelling-band fine screens, supplied by Ledward & Beckett Ltd., it is pumped into aqueducts extending the full length of the station. The total cooling-water requirement of the station will ultimately be 25 million gal./hr. and thus, during periods of low river flow, the use of cooling towers will have to be resorted to. After passing through the condensers, the water is returned to seal pits where it can be either returned to the river downstream, or pumped through the cooling-towers, the cooled water being returned to the suction side of the river pumps for recirculation. The river pumps are horizontal-spindle, split-casing, double-entry centrifugal units with a capacity of 70,000 gal./min. at 38-ft. head. They are driven by 1,030 h.p., 367 r.p.m., 3.3-kV motors supplied by English Electric Co. Ltd.

Alternators

Each of the six Metropolitan-Vickers hydrogen-cooled alternators is of 100-MW capacity and generates at 13.8-kV. By means of a transformer, this is stepped up to 132-kV on the first three machines, and to 275-kV on the last three. Main switching is carried out at these voltages. The hydrogen-cooling system of the alternators consists of gas control and seal oil equipment situated within and adjacent to the main foundation blocks of the machines. The hydrogen pressure is 0.5 lb./sq. in. for each alternator. All of the machines have gear-driven main and pilot exciters running at 1,000 r.p.m., operating in conjunction with automatic voltage regulators.

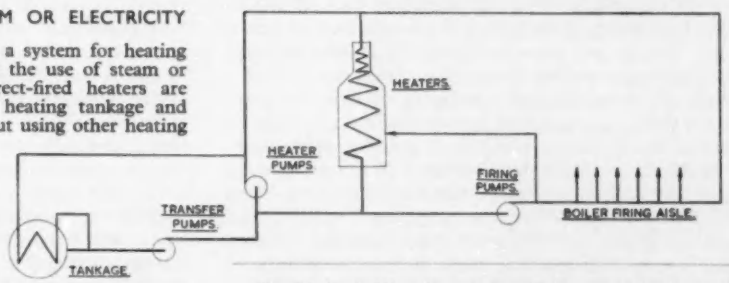
Station control room

The main station control room is in a separate building south of the transformer bays. It is a horseshoe-shaped room specially designed to give the operators the most convenient visual control of the mimic diagrams and indications to the generator transformer and feeder circuits on the 132-kV and 275-kV main transmission system. The centrally positioned control desk houses the necessary controls for regulation of the load and reactive output of the six generators. The switching of the main supplies to the station auxiliary system is also carried out from the control room. Protective relay panels, metering and telecommunication equipment are housed in separate rooms in the control building.

At the present time, the station is producing 69 million kWh a week (sent out), at a thermal efficiency of 33 per cent. For the past two years, the thermal efficiency has been about 32 per cent. (the highest figure achieved at any of the C.E.G.B. stations), with output running at over 2,000 kWh (sent out) per ton of coal consumed. The fuel cost (including handling), per unit sent out, brings the station results within the lowest grouping at between 0.3 and 0.4 pence. The total station cost of each unit sent out is just over 0.4 pence.

FUEL-OIL HEATING WITHOUT STEAM OR ELECTRICITY

Foster Wheeler Ltd. have developed a system for heating fuel-oil up to firing conditions without the use of steam or electricity for heating purposes. Direct-fired heaters are employed, and provision is made for heating tankage and offsetting heat losses from piping without using other heating media. The scheme is the result of Foster Wheeler's interests in both the boiler plant and oil-refinery plant spheres, and combines equipment extensively employed and proved in these fields. Auxiliary boilers, steam tracing, steam trapping, condensate handling and feedwater treatment are dispensed with, therefore maintenance costs are considerably reduced and overall thermal efficiency increased. Efficiencies up to approximately 80 per cent. are possible, based on a heating load consisting of heating fuel-oil to the firing temperature, and offsetting thermal losses from oil piping and tankage. The scheme is applicable to reasonably compact installations, such as power stations, having a total heating load of 10-million B.Th.U./hr. minimum and fuel-oil with viscosities up to 6,000 sec. Redwood No. 1 at 100 deg. F., and possibly higher. The only supplies required during normal operation are fuel-oil for the heaters, electrical power for the pumps and air or electricity supply for instrumentation. Capital costs would appear to be similar to those for a steam-heated scheme inclusive of steam generation, but operating and maintenance costs are claimed to be considerably reduced. The basic scheme is depicted in the accompanying flow diagram.



Diagrammatic arrangement of scheme developed by Foster Wheeler Ltd. for heating fuel-oil up to firing conditions without use of steam or electricity.

The United Kingdom Atomic Energy Authority announce that contracts have been placed with the following firms in connection with the advanced gas-cooled reactor project at Windscale: Whessoe Ltd. (Darlington), *reactor vessel*; English Electric Co. Ltd., *turbo-alternator and associated equipment*; International Combustion Ltd., *heat-exchangers*; Babcock and Wilcox Ltd., *containment building*; Hick Hargreaves Ltd., *dump-condenser*; Mather and Platt Ltd., *feed pumps*; Whatlings Ltd. (Glasgow), *building and civil engineering work*. In addition, Ewbank and Partners Ltd. (London) have been retained as consultants concerning the turbo-alternator plant and that part of the associated steam plant within the turbine hall. This reactor, to which reference was made in the fourth annual report of the Authority, and published in July last, will be a further development of the gas-cooled graphite-moderated power reactor system, of which Calder Hall was the initial prototype. By using ceramic fuel in the form of uranium oxide, and beryllium for the cans, it should be possible to operate at a considerably higher temperature (600 deg. C.) giving an increase in efficiency compared with the Calder plant. The experimental reactor will develop about 100-MW thermal and 28-MW electrical. A single-pressure steam cycle will be used at a pressure of 600 lb./sq. in.

Efficient Fuel Utilisation

A NUMBER of interesting papers, with the general heading "Lower costs and higher production through better fuel utilization," were presented at a series of technical meetings held under the auspices of The Institute of Fuel, in connection with the recent Industrial Fuel Efficiency Exhibition. Space limitations have hitherto prevented us from making more than a brief mention of the papers, but we now publish below extracts from two of these.

In the first paper, **"Operating characteristics of boilers in relation to steam demand,"** the author, E. G. Ritchie, D.Sc., A.M.Inst.C.E., M.I.Mech.E., F.Inst.F., F.I.Plant E., stated that his main purpose was to deal with one aspect of the problem created by the implications of the Clean Air Act in relation to the burning of fuel in industry—the nature of the steam demand on the performance of the boiler plant. The relationship, or rather the lack of relationship, between the two was, he suggested, the major cause of smoke and grit emission.

The only solution of the problem of fluctuating steam demand is to store thermal energy during off-peak periods and to regenerate this thermal energy to meet the peaks. In this way the firing rate can be stabilised and the steam pressure maintained constant, independent of the variation in demand.

The amount of heat in terms of steam that can be stored and regenerated in different ways in 3,500 cu. ft. of water (the approximate water content of four Lancashire boilers 9 ft. in diameter and 30 ft. long) is shown in tabular form in the paper, and the conclusions drawn by Dr. Ritchie are that the figures illustrate the fallacy that Lancashire boilers provide a comparatively large amount of thermal storage capacity by allowing the pressure to vary. In fact, the amount of heat storage so obtained, and over any practicable pressure range, does not measure up to the requirements of most industrial plants, and once the pressure has been allowed to drop it takes a long time to recover. It is true that this type of boiler helps to meet the early morning peak, but only at the cost of handicapping works processes throughout the rest of the day.

The steam accumulator is, of course, only applicable where a large part of the total steam demand can be met at pressures substantially below boiler pressure.

The figures also show the remarkably high thermal storage capacity that can be obtained by storing hot water at atmospheric pressure for process where this is practicable and useful, or in a closed hotwell at boiler pressure for boiler feeding.

The author then discussed the latest development in the thermal-storage field—the thermal-storage boiler—which combines, in one shell, the dual functions of a steam generator and a feed-water accumulator. In this type of boiler the heating surface, firing equipment, fans, ducting and chimney, etc., are all designed to meet the average steam demand, the shell being enlarged in diameter as compared with an ordinary boiler, to provide for a substantial rise and fall of water level. The rate of feed to the boiler is controlled by a regulator, pressure-impulsed from the steam main, so that with the oncoming of a peak, and with the consequent drop in steam pressure, the regulator closes and the water level in the boiler drops. With the occurrence of a valley in the steam demand the steam pressure tends to rise; this opens the regulator, and the water level in the boiler is regained. In short, during peak periods steam is raised from water at saturation temperature, and during off-peak periods steam is raised from water at hotwell temperature. The difference in the total heat of steam in the two instances, along with the flywheel effect of the enlarged water volume, enables the boiler to be fired at a constant rate over long periods, meeting a widely varying steam demand without variation in pressure, conditions ideal to the attainment of maximum thermal and productive efficiency in a works.

Change in average steam demand from one load level to another, for example from day shift to night shift, is effected by alteration in the rate of firing, and such change can be brought about slowly, with the help of a master firing gauge, which, in fact, shows the water level in the boiler. Control of rate of feed to the boiler is entirely automatic.

It will be appreciated that the peak load carrying capacity of a thermal-storage boiler is dependent upon the difference between hotwell temperature and saturation temperature.

Table 1 shows the maximum peak that can be met by closure of the feed-water regulator in terms of the equivalent rate of firing for a variety of conditions as to boiler pressure and hotwell temperature. Valleys of commensurate magnitude are covered by the opening of the feed-water regulator. Thus, in a thermal-storage boiler operating at 200 lb./sq. in. with a hotwell temperature of 120 deg. F. generating 15,000 lb. of steam an hour, load variations from 10,000 to 20,000 lb./hr. would be met without change in firing rate and without change in boiler pressure. The range of flexibility in Table 1 satisfies the conditions in most industrial plants, but where the peaks rise beyond the control of feed-water storage alone, this situation is met by combining the thermal-storage principle with limited automatic modulation of the firing equipment, and providing for this in the amount of heating surface incorporated in the boiler.

TABLE I—PEAK LOAD-CARRYING CAPACITY OF THE THERMAL-STORAGE BOILER

Hotwell temp. deg. F.	100 lb./sq. in. Ts 388 deg. F. (per cent.)	200 lb./sq. in. Ts 388 deg. F. (per cent.)	300 lb./sq. in. Ts 422 deg. F. (per cent.)
60	32	40	46
120	25	33	39
180	18	26	31

The duration of the peak which can be carried by the thermal-storage boiler depends upon the volume of water stored between high-water level and low-water level. Usually such boilers are designed to cover the maximum peak, as given in Table 1, and to bridge the corresponding valley for a period of about one hour, lesser peaks and valleys being, of course, covered for longer periods.

The first thermal-storage boiler, of the high velocity oil-fired Economic type, was installed at the works of Quaker Oats Limited, Southall, Middlesex, in 1955. (See ENGINEERING AND BOILER HOUSE REVIEW, November, 1956.) When operated at near maximum load, this boiler shows a day-in-day-out efficiency of over 80 per cent., measured in terms of steam to the factory against oil consumed, based upon the gross calorific value of the fuel. The steam pressure under all conditions remains constant, with a maximum variation of about ± 1.0 lb./sq. in. Similar boilers, both coal and oil fired, are now being installed in dyeworks, food factories, breweries, chemical works, printing works, etc., and in the millboard and plastics industries, in all of which the steam demand varies widely.

The second paper, **"Instruments and automatic controls in fuel efficiency,"** was presented by W. R. Kent, B.A.(Eng.), A.M.I.Mech.E., A.M.I.E.E., A.M.Inst.F., Kelvin and Hughes (Industrial) Ltd. After answering effectively the many reasons put forward for not using instruments in connection with small boiler installations, Mr. Kent dealt with the reasons for doing so. It was, he stated, a common misconception that a smoke-free stack denotes an efficient boiler. The wastage of heat in the flue gas is as great when surplus air is supplied for combustion as when there is a deficiency of air, this last condition causing smoke emission. Many small industrial boilers operate without the effective use of instruments, resulting in unnecessary losses caused by useful heat being carried away in the flue gases.

This state of affairs can be revealed by measurement applied to the flue gases. The gas analyser, however, has a difficult duty to perform, and in consequence has frequently been maligned. Flue gas is dirty and corrosive, and at a high temperature in the boiler flue. Continuous analysis of the gas therefore involves, primarily, the extraction from the flue of a sample which must be filtered and cleaned before it can be used for measurement. This gas sample contains a high water-vapour content which, when it condenses on leaving the flue, can easily cause blockage in the sampling pipe unless the pipe is properly drained. All these problems can be overcome by proper attention and regular maintenance.

It would be wrong, Mr. Kent continued, to imagine that gas analysis is the only measurement necessary in a boiler plant. The measurement of steam flow, without which no knowledge of load conditions or variation is available, temperatures at different parts of the plant, such as the economiser and so forth, and draughts, are also important. A steam flowmeter is a simple piece of equipment, but it is surprising that many boilers should still be operated without it. Sometimes feed-water measurements are made instead.

Temperature-measuring instruments are among the most straightforward, and yet they are often not used. A measurement of exit-gas temperature provides an immediate assessment of flue-gas loss, apart from the useful gauge of the cleanliness of the boiler flues which it gives the boiler operator. Draught gauges are commonly used to check damper settings, and as a measurement of gas-flow conditions, providing as they do useful information on air infiltration through brick settings.

Where process work causes sudden and violent variations in boiler loading, automatic controls may have to be added to measuring instruments. Automatic boiler control equipment suitable for operation in conjunction with small boilers is, of course, available. Such equipment is simple and versatile, and can be adapted to different types of boiler and firing arrangements. Control of steam pressure is the primary function of the automatic system, but maintenance of the air-fuel ratio under varying load condition is the means of achieving fuel economy.

With solid-fuel firing, methods of regulation vary according to the type of mechanical stoker. The operation of coal and air controls can be made "simultaneously" or "in cascade." Stoker controls can be provided to suit the type of appliance. Air controls cover a wide range of damper-operating motors.

In most instances, feedback corrections from the measurement of air flow in "balanced" draught boilers, and the flow of gas through the boiler passes in "induced" draught boilers, are made. Sometimes feed-back corrections from the fuel-feed rate are also introduced. These corrections reduce the effect of damper characteristics, and maintain the pre-set air-fuel ratio against independent variations in fuel or air rates which may arise in course of working.

With "induced" draught boilers, separate over-fire pressure regulators to maintain equilibrium in the furnace space are required. This is, however, a simple addition to the control system. It will be clear that air-fuel regulators are primarily responsible for the maintenance of efficient combustion, and must be set by the use of gas analysers. As fuel changes occur, these regulators are re-set from monitor readings, and are therefore dependent to some extent on measurement.

All automatic control systems are provided with overriding manual control arrangements which include adjustments for load sharing between boilers, and a means of introducing, manually, "raise" or "lower" increments whenever they are required.

Automatic controls for oil firing are usually simpler than those for solid fuel. According to the type of burner, oil and air controls can be regulated either "simultaneously" or "in cascade." In the normal system the master steam-pressure controller operates one servo motor. This motor regulates the oil valve and air controls, either damper or louvres, together, through suitable linkage. Linkage is arranged to allow for the relative valve and damper characteristics, but must be set from a gas-analysis reading, and, as with solid fuel, may require re-setting from time to time.

In conclusion Mr. Kent said that the proper use of instruments and controls demands co-operation between user and supplier and, with this in view, a joint committee was recently formed between the National Industrial Fuel Efficiency Service and the British Industrial Measuring and Control Apparatus Manufacturers' Association. One of its objectives was to promote recommendations as a formula for co-ordinating sound standard practice in small-boiler instrumentation. Terms of reference of this committee were broadly allied to the proper maintenance and use of instruments. However, a most significant phase of its work will come shortly, when it is hoped to hold a joint meeting with representatives of the Combustion Engineering Association. The object of this meeting will be to investigate recommended standards of essential instrumentation for various sizes and types of boiler.

550-MW Reheat Boiler Unit for Thorpe Marsh

IN the March, 1958, issue of this journal we published some brief particulars of the 550-MW reheat boiler unit which is being constructed by International Combustion Ltd. for the Central Electricity Generating Board, for installation at Thorpe Marsh generating station, near Doncaster. So far as is known, this boiler is the largest single steam-generating unit at present under construction in the world.

For this extremely large boiler with its very high evaporative rating of 3.75 million lb./hr., International Combustion Ltd. submitted a twin-furnace controlled-circulation design which would allow for the unit being capable of satisfactory operation over protracted periods, burning fuels with a wide range of moisture and ash content, together with a relatively low ash-fusion temperature. It might here be mentioned that what are regarded as the most difficult coals in the country will probably form the bulk of the fuel to be consumed in the furnaces of this boiler.

Development work has progressed satisfactorily following the decision to proceed with the design, and during this period there has been a continuous demand for additional technical information concerning this outstanding unit. Thus, International Combustion Ltd. recently took the somewhat unusual course of releasing details concerning the main features, where the design has reached an advanced stage.

The operating conditions of the boiler will be:

Evaporative capacity (lb./hr.)	3,750,000
Steam pressure (lb./sq. in.)	2,400
Steam temperature (deg. F.)	1,055
Reheat steam temperature (deg. F.) ..	1,055
Feed temperature (deg. F.)	496
Guaranteed efficiency (per cent.) ..	90

(Based on the gross calorific value of the fuel.)

Circulation system

The adoption of controlled and assisted circulation follows logically on other current designs in which the natural circulation potential, due to the thermal head, is augmented by a pumping system. This system permits tubes of comparatively small inside dia. to be used for both risers and downcomers, and the consequent use of a thinner wall and reduced temperature gradient across it enables safety of operation, and economy of capital cost to be achieved simultaneously. The amount of water, and the rate at which it is supplied to each evaporating circuit is matched to the calculated heat absorption rate of each individual circuit by control nozzles. These nozzles are designed to improve circulating stability of the circuit, so that wide fluctuations of heat absorption do not result in over-heating of the tube metal on account of variable external fouling of the heating surface.

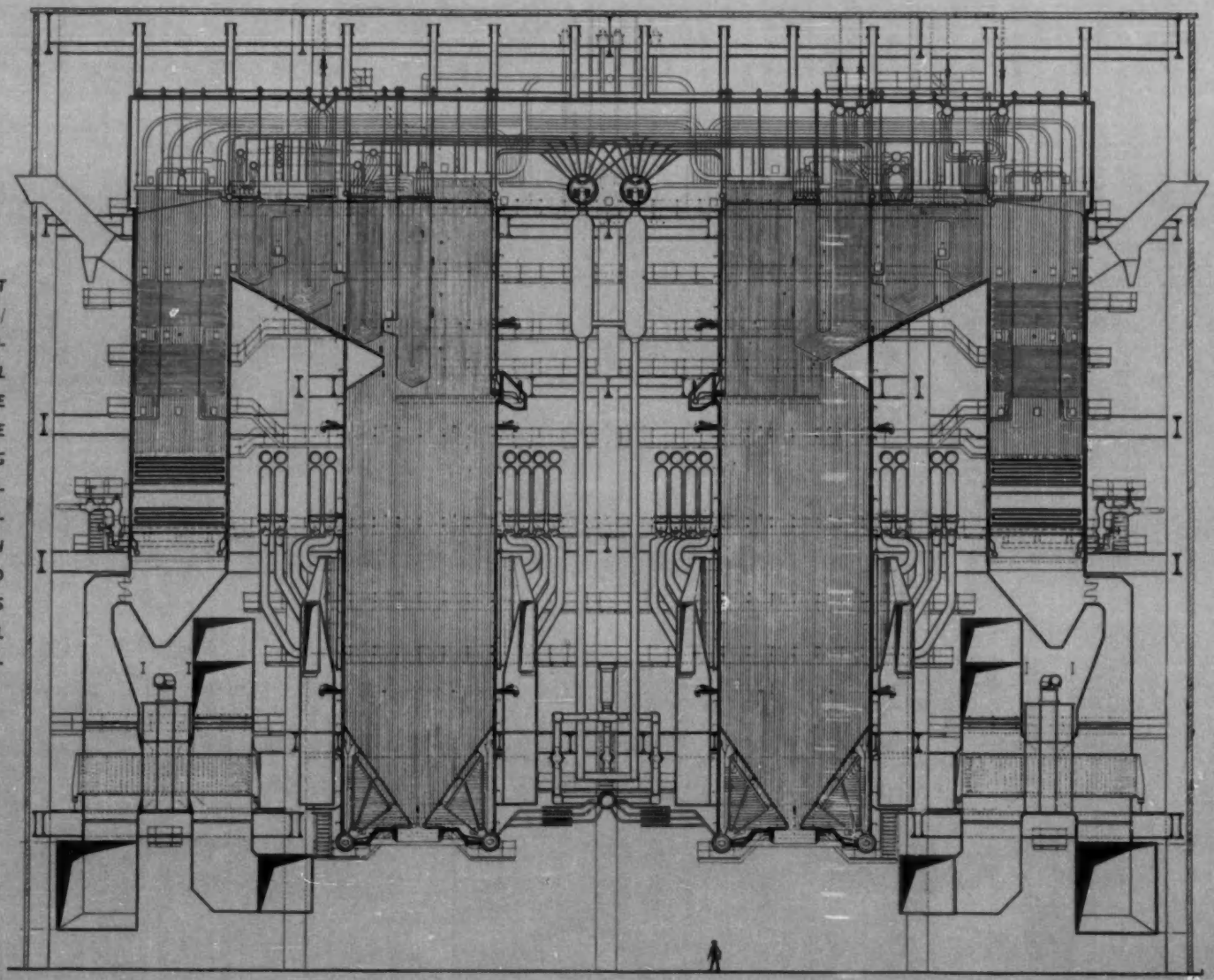
Although the boiler is divided into two separately-cased twin-furnace units, each 68-ft. wide by 28-ft. deep by 100-ft. high, and sub-divided by a partition wall and provided with two steam release drums, the unit forms one single entity with both drums connected into the circulating system of the furnace so that the system operates as a unified and balanced unit with a single arrangement of water-level control. The water from each drum is extracted by equal downcomer legs to centrally-positioned circulating pumps, which in turn discharge to a common manifold. From here, multiple feeder tubes supply both furnaces whilst the riser tubes forming the furnace walls discharge equally to both drums. The steam output from both furnaces is, therefore, equally distributed to both drums. Feedwater is also equally divided, and ample cross-over pipes below the normal water-level balance the water flow equally between the two drums. Equal steam withdrawal from both drums is ensured by taking half the steam to each of the primary superheater headers.

This simple unified system ensures that any one circulating pump will operate satisfactorily and feed both furnaces equally and simultaneously. With this arrangement, biased firing, will not disturb the water-levels or the steam pressure, a particular advantage during steam-raising periods. The centre-line of each of the main steam and water drums will be 148-ft. 6-in. above the p.f. mill floor-level. Careful design has been required to limit this height, which is not excessive in view of the size of the boiler, and when it is realised that in a unit boiler serving a 200-MW set, the height of the centre-line of the drums is 135 ft.

Six circulating pumps will be installed, five of which will maintain the design circulation rate at maximum continuous rating. Indeed, it is anticipated that four pumps will be adequate for this purpose, whilst a corresponding number will be sufficient for lighter loads.

These pumps which are being made and supplied by Hayward Tyler & Co. Ltd., Luton, to the order of International Combustion Ltd., are glandless units, each designed for a throughput of 8,800 gal./min., with a suction pressure of 2,575 lb./sq. in. Each pump will be driven by a 500 b.h.p. motor at a speed of 1,450 r.p.m. These pumps will be arranged integrally with the downcomer system, and the design is of a character which will allow for the elimination of differential expansion, and the consequent complication of piping. Fully-automatic sequence control will be incorporated for starting the pumps in the event of failure. The pumps themselves are to be of the vertical-spindle, single-stage, centrifugal design, driven by a squirrel-cage induction motor whose windings will be immersed in the circulating-water. The motor casings are being constructed to withstand the

CROSS-SECTIONAL ARRANGEMENT OF THE 550-MW (3.75 MILLION LB./HR.) REHEAT BOILER BEING CONSTRUCTED BY INTERNATIONAL COMBUSTION LTD. FOR THE THORPE MARSH POWER STATION OF THE CENTRAL ELECTRICITY GENERATING BOARD. AS BOILER WATER TEMPERATURE APPROACHES THE CRITICAL POINT, NATURAL CIRCULATION BECOMES INAFFECTIVE AND FORCED OR CONTROLLED CIRCULATION IS NECESSARY. THUS, THIS UNIT WILL OPERATE ON THE ASSISTED CIRCULATION PRINCIPLE



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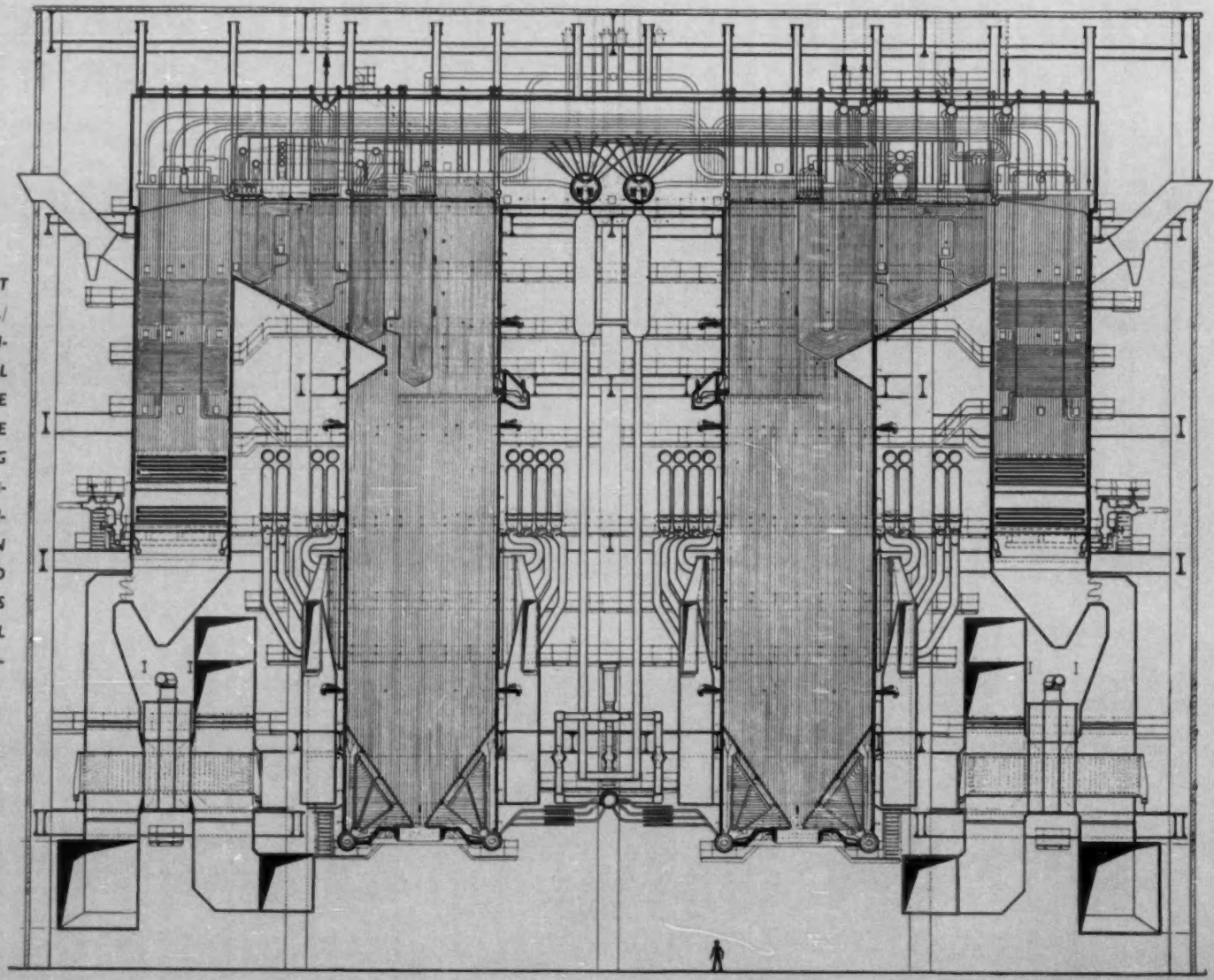
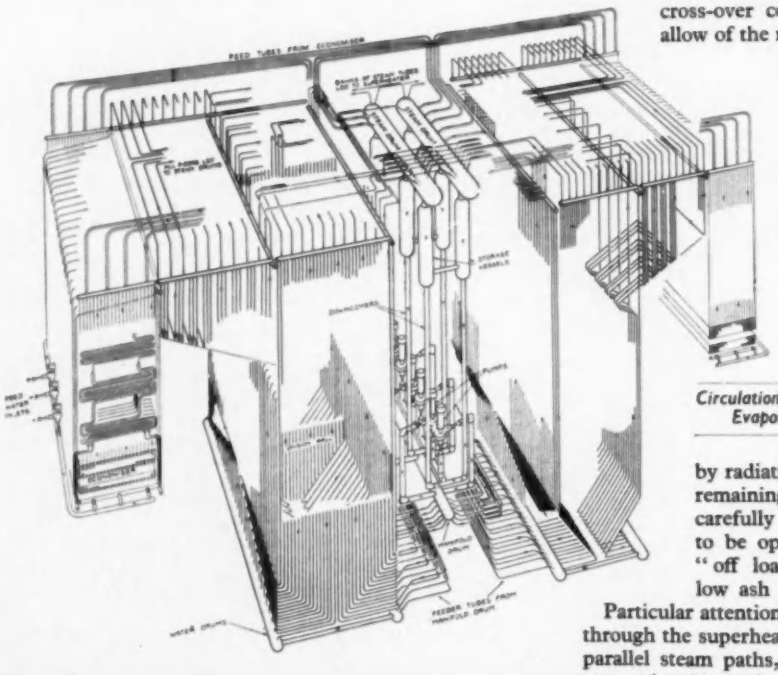


full operating pressure of the system, whilst the windings are of a special design, capable of withstanding the pressure. An external cooling system will be provided to ensure a satisfactory temperature level.

After separation in the drums, the steam will pass through turbo-separators and scrubbers to the superheater, with the water at saturation temperature passing around the drums before returning to the circulating pumps. This will ensure that the whole of the drum interior surface is maintained at a uniform temperature, a feature which will be a very great advantage during a quick start.



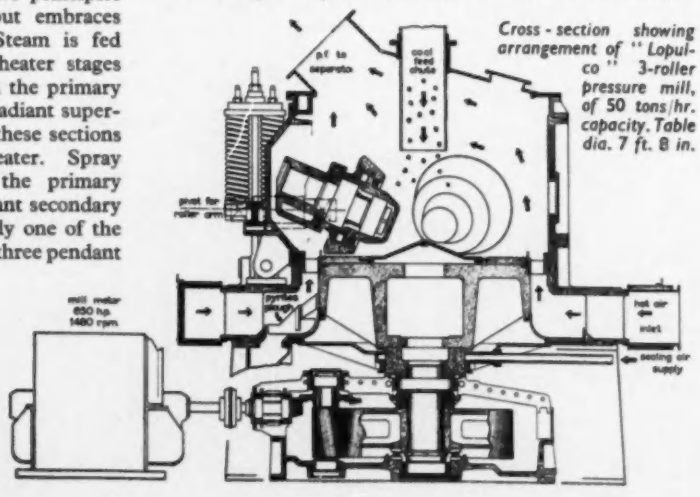
Circulation diagram for 550-MW reheat boiler. Evaporative capacity 3.75 million lb./hr.

Superheaters and reheaters

In general, the superheater design follows principles already established for 200-MW units, but embraces certain advances in detailed approach. Steam is fed directly from the drum to primary superheater stages located in each of the two furnaces. From the primary elements, steam is taken across the roof to radiant superheater panels in the front and side walls; these sections forming the outlet of the primary superheater. Spray de-superheaters are interposed between the primary superheater outlet and the inlet to the pendant secondary superheater stages, which are located in only one of the boiler furnaces. The reheater is arranged in three pendant sections in the other boiler furnace, in a location corresponding to that of the secondary superheater. The front stages of the reheater are of multiflow "U" formation to satisfy the low-pressure drop requirements. The total gross heating surface of the superheater is 258,430 sq. ft., whilst that of the reheater is 59,420 sq. ft. The combined length of tubing required is 168 miles, with a total weight of over 2,000 tons. At c.m.r. the heat added in the superheater and reheater is almost 50 per cent. of the total heat absorbed in the boiler unit.

In line with current practice, heating surfaces have been so arranged and judicious use made of cross-over connections and double headers to allow of the maximum effective use of inexpensive carbon and low alloy steels; thus reducing to a minimum the use of costly austenitic materials. The final stage of both superheater and reheater is located away from the hottest zone at the top of the furnaces. In the highest gas temperature zone, widely-pitched platen superheater elements are employed with tangentially disposed tubes. These sections, in which the heat transferred is predominantly by radiation, are largely self-cleaning and the remaining stages of the superheater are carefully graded in pitch, allowing the unit to be operated for lengthy periods without "off load" cleaning, even when burning low ash fusion coals.

Particular attention has been paid to steam distribution through the superheater with its necessary multitudinous parallel steam paths, and an adequate system of cross-over tubes is employed so that there is automatic compensation for any inequality in heat absorption. Radiant superheater panels have been installed in the front and side walls at the top of the furnace, thus permitting the maximum economy of convection surface, and considerably improving the steam temperature control characteristic. Spacing of the pendant elements across the boiler width is effected by tubular spacers included in the water circuit of the boiler and full use is made of the tangentially welded tubes in the detailed element



Cross-section showing arrangement of "Lopulco" 3-roller pressure mill, of 50 tons/hr. capacity. Table dia. 7 ft. 8 in.

construction, thereby avoiding the use at elevated temperatures, of heat-resisting steel.

Steam temperature control

With the advance to the high levels which have been reached in steam and reheat temperatures, the importance of close temperature control cannot be over emphasised, not only for the sake of the turbine efficiency, but also to keep the metals of the boiler itself, the steam piping, and turbine blading within what can be considered as safe operating limits. Spray-type desuperheaters are installed for emergency use, but the primary steam temperature control is obtained by tilting burners on both the superheater and reheater furnaces. For this purpose, a burner assembly is installed in the four corners of each subdivided furnace. Each corner burner assembly will comprise four coal nozzles and secondary-air nozzles, arranged to discharge tangentially to an imaginary circle in the centre of the furnace to form a vortex. These will be so arranged that they can be adjusted automatically in a vertical plane between an angle of $+30^\circ$ and -30° to the horizontal, so that the flame mass is projected into any desired position within the furnace between these limits. This design will have the effect of varying the furnace exit temperature and consequently the superheat and the reheat temperatures. It is anticipated that constant temperature will be maintained within $\pm$ 10 deg. F. over a range of 70 to 100 per cent. of the maximum continuous rating. Developed over a number of years, experience has shown that this system of steam temperature control responds rapidly to any change in operating conditions, and even with the large furnace, penetration of the jets to the centre of the furnace and the resultant turbulence of the gases, assures a high standard of combustion efficiency. Progressively increased in size, each of the coal nozzles for this very large boiler is designed to be capable of handling approximately six tons of coal/hr. with an associated air quantity of 60 tons/hr.

Milling equipment

The mills, specially developed for the large quantity of coal which will be consumed by the twin furnaces (approximately 200 tons/hr.), will individually be very much larger than any other p.f. mills at present in commercial operation for coal burning. Eight Lopulco, three-roller mills will be installed (four for each furnace) each capable of handling over 50 tons/hr. of coal: but six will normally be in operation, thus allowing for two mills to act as standby and for service when any of the other mills are out of service for maintenance purposes. Each mill is to be capable of handling coal with a moisture content of up to 28 per cent., using hot air at a temperature of 550 deg. F. for drying the fuel. The mill will have a centre feed, enabling the outlets to be suitably positioned in order to provide a vertical straight-through feed to the mill itself without bends which would restrict the flow of wet and sticky coal. To achieve this, the classifier will be positioned separately from the mill but in close proximity to it. The over-size, hot, dry rejects from the classifier will be re-delivered to the centre main feed chute, mixing with the incoming wet fuel and thus assisting both in movement down the chute and drying within the mill itself. Pyrites and tramp iron will be extracted from the mill in a manner similar to that employed on other standard Lopulco mills in service with many large power station boilers. The fuel discharged from each mill will be equally distributed to each half of the furnace and the output of each mill will discharge to a single tier of burners: but the firing rate can be biased in favour of one or other of the furnaces if required. The general design of the Lopulco three-roller pressure mill is shown in the accompanying illustration. Each mill will be driven by a 650 b.h.p. motor operating at 1,480 r.p.m. Lubrication of the gearbox will be by pump and the roller arm by drip feed, at a suitably controlled pressure in order to assure adequate, but not excessive, lubrication. The complete draught plant, the air-preheaters and the mechanical dust-collectors are being supplied by James Howden & Co. Ltd. The four Howden rotary type air-preheaters, with a total heating surface of 1,208,000 sq. ft. will be the largest regenerative air-preheaters ever built. The four Howden forced-draught and four Howden induced-draught fans will handle a total of 3,150,000 cu. ft. of air and gas per minute. The f.d. fans will be driven by motors of approx. 905 h.p.—this figure depending upon the finally selected fan speed. The two-speed motors driving the i.d. fans will each be of approx. 1,660/1,070 h.p.

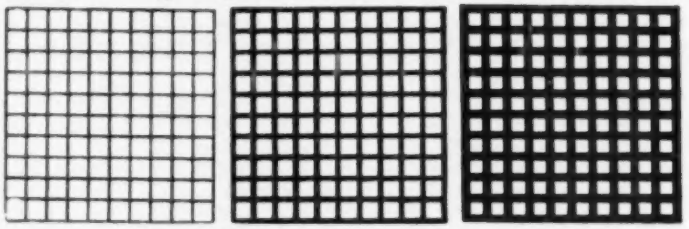
The electro-precipitation plant is to be constructed and supplied by Simon-Carves Ltd. The precipitator gas volume will be 1,540,000 cu. ft./min. This is believed to be the heaviest duty yet proposed for precipitators on a single boiler unit anywhere in the world. Under average conditions, dust will be removed by the precipitator at a rate of about 12 tons/hr., and the chimney emission will, it is estimated, be considerably less than 0.1 grain per cu. ft.

CONTROL OF FLUE GAS CORROSION

The Midland Tar Distillers Ltd. have recently made available their latest publication, "The Use of Teramin Inhibitor for the Control of Corrosion Caused by Flue Gases," which deals with the problem of flue gas corrosion when burning sulphur-bearing fuels, and the inhibition of such corrosion by metal passivation using Teramin bases. The name Teramin is a registered trade mark. Rates of dosage are extremely small and with the foregoing points in mind equipment should be designed on the simplest possible basis. Taking an optimum feed rate of 0.03 per cent. to 0.04 per cent. by weight on the rated capacity of the combustion equipment gives a figure for static air heaters of 5 to 7 c.c./min. of inhibitor per ton of fuel oil burnt per hour. On the largest of installations, e.g., power station boilers, a boiler consuming 15 tons per hour of fuel oil will require 75 c.c./min. of Teramin. This is precisely 1 gal./hr. and a 45-gal. drum in which the material is normally delivered will, therefore, serve such an installation for approaching two days on a continuous load. With rotary air-heaters of the Ljungström type wherein the total surface area of the heat exchange element is much less than that of a static type heater, it is possible to localise the application of Teramin. This can be done by injecting Teramin continuously above the rotor at its point of entry into the gas stream. Boiler plant of intermediate size such as Lancashire boilers with economisers to be protected will require some 3 c.c./min. per Lancashire boiler (30-ft. × 8-ft. 6-in.). Smaller installations such as central heating boilers and packaged boilers may require considerably less than 1 c.c./min. of Teramin. In all cases with the exception of the rotary heater the problem is to introduce a comparatively small quantity of inhibitor into large volumes of hot flue gases and to ensure an even distribution of the vapour. Wherever possible a point should be chosen in the flue gas system where the gas temperature lies between 392 and 572 deg. F., and the choice of one or a multiplicity of injectors must depend upon the cross sectional area of the flue at the point of injection together with a consideration of the aerodynamics of the system.

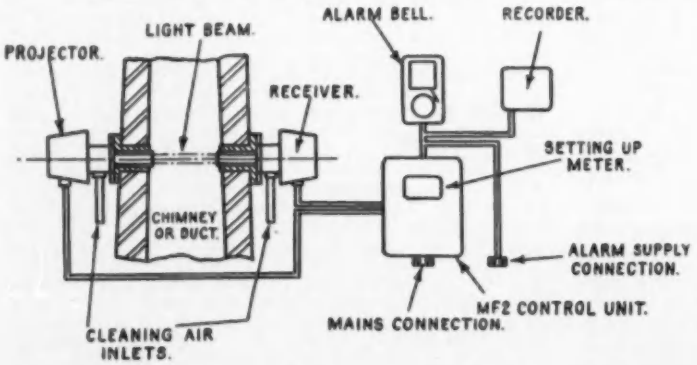
Smoke Density Alarms and Meters

IT is well known that the emission of dark smoke from chimneys was prohibited when the remaining provisions of the Clean Air Act came into force on June 1st, 1958. Since that date industrial and commercial undertakings have been required to operate their plants with a minimum emission of dark smoke. In the Act, dark smoke is defined as smoke which if compared in a particular way with a Ringelmann Chart appears as dark as, or darker than Shade 2 on that Chart. A diagram of the Ringelmann Chart is given in Fig. 1. Dark smoke is, of course, an indication of incomplete combustion, waste and inefficiency in the use of fuel, and it is generally agreed that provided the plant is in good order and suitable fuel is being used, the reason for undue smoke emission usually lies with incorrect plant operation.



Since visibility of the smoke from industrial and commercial chimneys is the main factor recognised by the Clean Air Act it will be more than ever necessary in future, for plants capable of emitting smoke to be equipped with reliable optical density measuring and warning devices. The particular types of such equipment described in this article, and manufactured by A. M. Lock & Co. Ltd., Oldham, Lancashire, carry out this optical density measurement by utilising a light source and photocell positioned at special windows on opposite sides of a duct or chimney.

In operation, a beam of light from the projector is focused on to a vacuum type emissive photo-electric cell in the light receiver, which is mounted on the opposite side of the chimney. Smoke passing up the stack reduces the amount of light reaching the photocell, the amount of obscuration being dependent upon the actual density of the smoke. In the simple smoke alarm, when this obscuration reaches a pre-set amount, the alarm relay in the electronic control unit reacts to operate a visual or audible warning device. With the comprehensive equipment, the amount of obstruction is indicated on a meter and if necessary is recorded on either a strip or circular chart, an alarm being given when the smoke density exceeds a pre-set amount. A typical complete installation is shown diagrammatically in Fig. 2.



Stack-mounted units

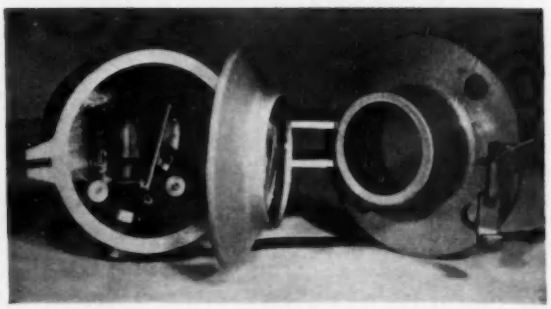
The stack units for the smoke alarm and smoke meter are basically similar, the same weatherproof aluminium castings are used in each form of equipment, but the simple electronic unit is slightly different for the two types. The light projector uses a rugged low voltage lamp, and the light receiver unit a vacuum emissive type of photoelectric cell, which for this particular type of application has advantages over the alternative selenium type of cell. Both robust stack units have standard flange mountings for bolting on to the chimney and they require a minimum hole size in the chimney or duct of $3\frac{3}{8}$-in. They are provided with a simple double hinge arrangement giving quick access to the low voltage lamp or photocell and to the lenses for easy cleaning. This arrangement is shown in Fig. 3.

For reliable and accurate operation over long periods, care has been taken in the design and arrangement of the stack units in order to reduce to a minimum any inaccuracies due to soot and dust deposits in the optical

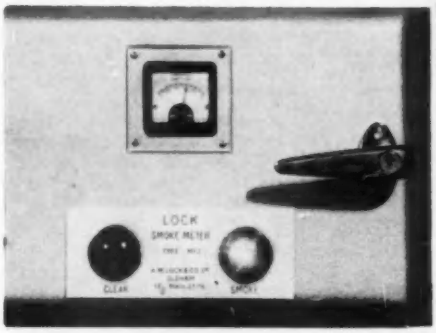
Fig. 1 (above). Sections of the 4 in. versions of Nos. 1, 2 & 3 of the Ringelmann smoke chart.

Fig. 2 (left). Diagrammatic arrangement of Lock smoke meter, alarm and recorder.

Fig. 3 (below). Unit for stack mounting, showing double hinge arrangement.



system. The recommended method of mounting these units is that the two tubes protruding into the chimney with their chamfered ends should be arranged so that the distance between these ends is approximately 6-ft. If possible, the stack units should be installed where a negative pressure exists in the chimney so that clean air will be drawn in through the bleed hole provided in each stack unit. The chamfered tubes and the clean air which is drawn into the units ensure that the optical system remains clean for long periods. The junction between the tubes and stack units themselves forms an air-tight seal, but the hinge arrangements referred to above enables this seal to be easily broken and remade after the occasional cleaning of the lenses. If it is not possible to install the stack units at a point where negative pressure exists, then the tapped bleed hole, mentioned above, can be used for the introduction of a forced-air flow.



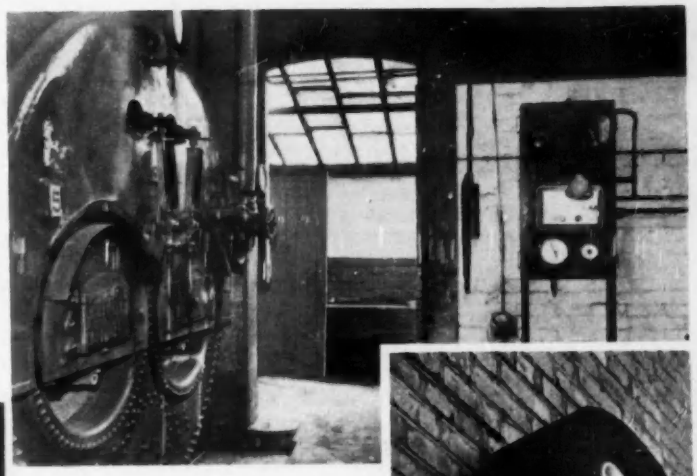


Fig. 6 (above). Smoke meter installed in the boiler house at a cotton mill.

Fig. 4 (left). Electronic control unit Type MF2 for smoke meter.

Fig. 7 (right). Stack unit mounted in position on side of brick chimney.

Simple smoke alarm

This equipment is suitable for application to chimneys having an external dia. of up to approximately 12-ft. It monitors continuously the smoke in the duct or chimney and automatically sounds an alarm should the smoke density exceed a pre-set amount—usually that equivalent to Ringelmann 2. Such an installation consists of the

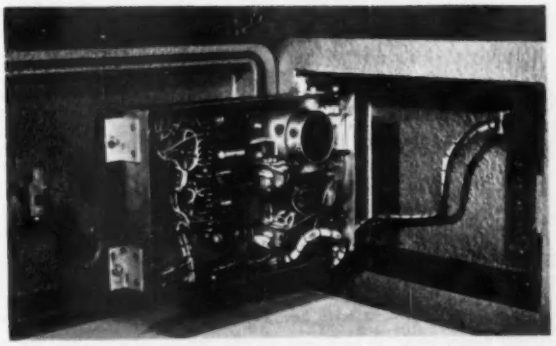


Fig. 5. Smoke meter showing chassis hinged forward for inspection purposes.

stack-mounted units described above, together with an electronic alarm unit mounted in a dust-tight cast-aluminium case which can be fitted at any distance up to 100-ft. from the stack units. The built-in heavy duty relay has contact ratings of 250 volts 5-amp non-inductive loading, and is used to operate visual or audible alarms. To complete the installation an inkless-type alarm recorder is available which records the times and duration of the emission of excessive smoke.

Combined smoke alarm and recorder equipment is available comprising an electronic alarm unit (type SA_1), and the alarm recorder unit built into one dust-tight cast aluminium case. It connects to the standard stack-mounted units. This system reduces the amount of installation and panel space required to an absolute minimum. The combined unit can be mounted at distances up to 150-ft. from the stack units.

Continuous smoke density recording equipment

This comprehensive equipment provides a continuous indication of smoke density throughout the full 24 hours. It is an aid to the maintenance of efficient combustion as well as providing effective warning of the emission of dark smoke. Stack-mounted units as described earlier are fitted on to the chimney which can be up to 22-ft. in dia., using standard equipment. The electronic control unit, type MF2 (Fig. 4) in its dust-tight cast-aluminium case is fitted in any convenient position up to 150-ft. from the stack units. The small meter on the front panel of the control unit is provided for setting-up and monitoring purposes, it is calibrated in percentage light loss, zero light loss corresponding to clear stack conditions, and 40 per cent. light loss approximating to Ringelmann 2. The control unit provides an electrical output of 0-5 milliamps for operating remotely-mounted, large-scale indicating-meters and circular or strip chart type recorders. The electrically-operated heavy-duty

alarm relay has contacts which are capable of handling loads of 250 volts 5-amps non-inductive for operating alarm bells, hooters, etc. An additional feature of the control unit is a special built-in delay system which prevents the alarm being sounded unnecessarily by short duration puffs of smoke. The electronic chassis of the MF2 control unit incorporates the following initial setting-up controls which are immediately accessible on opening the locked front door :—set zero, set 100 per cent. light loss, set alarm point, set alarm delay. The chassis hinges forward for inspection and plug-in construction has been adopted to allow for ease of replacement in the event of a failure. The control unit in addition to housing the measuring circuits also provides the various stabilised power supplies required, including that for the lamp in the projector unit. This stabilisation of the lamp voltage is of great importance if accurate results are to be obtained because the light output from the lamp is proportional to $\frac{V^2}{R}$ where V is the voltage to the lamp.

Checking alarm set point

In order to readily check the alarm set point, a special cam-operated light-absorption filter is built into the light receiver unit and provides a pre-set obscuration of the light beam by an amount equivalent to the alarm level of smoke. This filter is initially adjusted after the alarm point has been set by observation of the smoke emitted. It is then only necessary to turn the filter arm to the check position when the stack is clear of smoke and the alarm should sound. In installations where it is not convenient to manually turn the filter arm for checking purposes, an automatic device is available for fitting to the light receiver unit. This enables the filter to be inserted remotely at the electronic control unit. The operating device fitted to the light receiver unit is a simple solenoid actuator.

The equipments described above utilise the latest circuit design and engineering techniques and meet the requirements of the relevant British Standards Specifications. A wide range of accessories is available to cover the requirements of all types of installations.

A smoke meter control unit, large-scale indicating meter, and alarm bell, installed in a boiler house are shown in Fig. 5, while Fig. 6 illustrates a stack unit fitted in position on a chimney. The use of such equipment will greatly assist boiler plant operators in their efforts to reduce smoke emission, and to meet the requirements laid down in the provisions of the Clean Air Act.

I.C.I. TO BUILD EUROPE'S FIRST BERYLLIUM PLANT

Imperial Chemical Industries Limited, Metals Division, is to establish the first plant in Europe for the production of wrought beryllium. The plant is designed to produce semi-fabricated forms of the metal, such as rod, tube and plate, and finished machined parts. Its first task will be the carrying out of a production scale contract placed with I.C.I. by the United Kingdom Atomic Energy Authority (Industrial Group) as part of a nuclear development project.

Interest in beryllium as a nuclear engineering material has been intensified by the need for a metal which will perform satisfactorily in the higher operating temperatures envisaged in gas-cooled reactors. For the present programme of British reactors, operating at temperatures up to about 470 deg. C., special magnesium alloy materials are used for sheathing the nuclear fuel. For higher temperatures needed to obtain increased thermal efficiency, materials with greater strength at these temperatures must be used and the most promising of these is beryllium, which has a melting point of 1,280 deg. C., is light in weight, has good mechanical properties and good corrosion resistance to carbon dioxide at elevated temperatures. In addition, beryllium has by far the lowest neutron absorption cross-section of any of the possible constructional metals. For this reason, the Industrial Group, U.K.A.E.A., intends to use beryllium fuel cans in its advanced gas-cooled reactor, in which fuel element surface temperatures as high as 600 deg. C. are planned.

The handling and fabrication of beryllium involve specialised techniques to overcome difficulties arising from its particular metallurgical characteristics and from the toxic properties of the metal in certain compounds and forms. Thanks to considerable research which has been carried out into the safe handling of beryllium products by the U.K.A.E.A., stringent standards of operation have been evolved and codified, and the I.C.I. plant will incorporate all the special features which have been found necessary for this purpose. Some unusual features are involved in the manufacture of wrought forms of beryllium. The metal, which is received as flake or as small beads, is melted under vacuum in induction furnaces to produce an ingot.

I.C.I. Ltd. has been entrusted with this task following its already considerable contributions to the development of nuclear metallurgy. In the very early days, it solved problems connected with the extrusion of uranium, and undertook the production of porous barriers for diffusion membranes in uranium isotope separation plant.

Much of the early work in devising suitable forms of sheathing (or " canning ") for nuclear fuels was done by the Metals Division in conjunction with the Authority. I.C.I. aluminium cans are in use in many of the experimental reactors at Harwell and elsewhere, and the division has manufactured and supplied prototype cans in magnesium and zirconium alloys to all the consortia in this country and to official bodies abroad.

Marston Excelsior Ltd. (an I.C.I. subsidiary) was one of the first commercial undertakings to be associated with the U.K.A.E.A. in the assembly of research reactor fuel-elements containing enriched uranium, and has supplied ancillary coolers and brazed assemblies for the burst cartridge monitoring system at Calder Hall. Berkeley and Bradwell-on-Sea power stations will incorporate nearly 400 miles of I.C.I. " Integron " steel tubing in their heat exchangers.

The Superheater Company Limited, who recently moved their London head office from 53, Haymarket, S.W.1, to a new building at 97, Tottenham Court Road, W.C.1, welcomed representatives of their many friends to their new headquarters on Thursday, November 27th, 1958. For almost half a century, the Superheater Company and its predecessors has an unbroken link with the evolution of the superheater and the use of superheated steam. The company's achievements are well known and recognised, covering a vast range of designs from the earliest applications to locomotive, marine and power plant boilers, including the high-temperature superheaters and reheaters for the world's largest single boiler to be built at the Thorpe Marsh Generating Station for the Central Electricity Generating Board, and as described elsewhere in this issue. The more recent establishment of its Nuclear Energy Division should ensure that the company will also take its place in the forefront of this latest field of power generation. The manufacturing division of the company is already fabricating nuclear heat-exchange equipment, and the technical staff of the Nuclear Energy Division is fully-equipped to handle any problem of heat-exchange associated with nuclear power generation. Heat Exchangers Limited, a subsidiary of The Superheater Company, is also housed in the same building at 97, Tottenham Court Road, and its specialist design team, re-inforced by the accumulated manufacturing knowledge of the parent company, completes the overall coverage of heat-exchange problems by the " Superheater Group." The activities of Heat Exchangers Limited embrace an ever extending and varied field, including non-steam nuclear heat-exchangers, in addition to all types of heat-exchange equipment for the chemical, gas turbine and electronic industries.

RECENT Equipment AND Accessories

Oil-fired heat-exchangers

A fully-automatic air-heater, known as the "Airwoods," manufactured by Woods of Colchester Ltd., has been designed as an economical and simple method of supplying hot air through ducting for space heating or drying purposes. The units incorporate Woods "Aerofoil" fans, and any air volume/pressure combination can be obtained by using single-stage or multi-stage fans of various sizes. Within a cylindrical casing, the unit incorporates a radial finned bank combined with a combustion chamber into which fires a Nu-way jet-oil-burner. Air is passed through the casing, over the radial fins, and absorbs about 80 per cent. of the heat generated by the burner. There is no contact between the air flow and the products of combustion which pass to a flue stack. Two designs are available:—a straight-through type for high-temperature rise with low air supply, and a by-pass type for low-temperature rise with high air supply. Heat outputs range from 66,000 to 1,280,000 B.Th.U./hr. Automatic flame-failure control is supplied. The units are relatively light in weight, and may be mounted horizontally, vertically or inclined, on the floor or in a roof space. (*Woods of Colchester Ltd., Colchester, Essex.*)

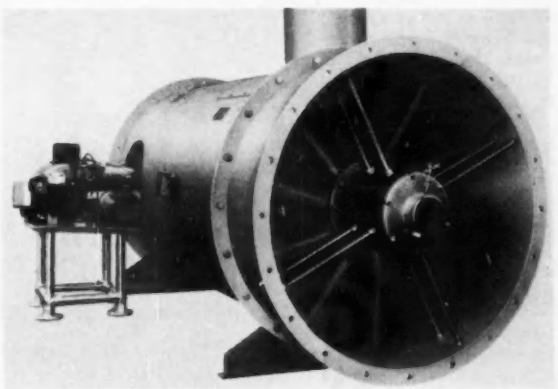


Fig. 1 (left). The "Airwoods" fully-automatic air-heater. These units incorporate Woods "Aerofoil" fans. (Woods of Colchester Ltd.)

Cable reel jack

An extension to their range of Duff-Norton ratchet lowering jacks has been made by the Consolidated Pneumatic Tool Co., with the introduction of a special model for handling cable drums. In construction and operation the new model follows the main features of the existing range, but includes three specially shaped lugs as hooks for accommodating the drum spindles at heights of 8-in., 16-in. and 24-in. from the ground. Duff-Norton jacks use the familiar lever and fulcrum principle to lift and lower the load. The downward stroke of a lever, acting through a short pawl, raises a hardened steel, square, notched bar or rack by one lift. A long pawl then slips into place to hold the load whilst the lever is being raised to engage a further notch. Controlled ratchet lowering is effected by reversing the mechanism. The cable drum unit, whilst of particular application to straight cable laying operations, will also meet a need for a simple device in many sections of industry where cable drums of many kinds are handled, such as in the servicing of haulage ropes, hoists, winding gear and mooring cables. Specifications of the cable reel unit include a weight of 66-lb. and a maximum working load of 5-tons per jack. The hooks will accommodate 2-in. diam. spindles, and the wooden base-plate used measures 2-ft. by 9-in. by 2-in. (*Consolidated Pneumatic Tool Co. Ltd., 232, Dawes Road, London, S.W.6.*)

Redesigned depth gauge

The latest "Clyde" depth gauge, for all types of bulk storage tanks, has recently been redesigned by the manufacturers, Buchanan Brothers Ltd., to provide a clearer and more easily read dial, and is now available with 6-in. or 10-in. dia. dials. The maximum tank depth for the former is 6-ft., and the latter 10-ft. Each gauge is calibrated separately to read correctly at any depth, and to facilitate this, dimensions of the tank should be supplied when ordering The dial of the gauge has large black figures on a white background, and a red line indicates the "float grounded" position. (*Buchanan Brothers Ltd., Commerce Street, Glasgow, C.5.*)

Adjustable pipe-clamps

Courtburn Positioners Ltd. have designed and are now manufacturing a range of adjustable pipe clamps, which both hold and align the pipes externally for butt-welding. At present, three sizes are available to accommodate all pipes from 6-in. to 24-in., and each clamp caters for pipe sizes over a 6-in. range. Larger sizes can be made to customers' special requirements. The clamp is strapped round the two butted pipe ends to be welded, double claws are engaged on the nearest distance piece, and the hand wheel turned until the clamp grips the pipe ends in perfect alignment for butt-welding. Space can be left between the pipe ends for the weld filler as required. The clamps can be used *in situ*, or on a bench, and they can be slackened-off and eased round the pipes for complete accessibility as welding proceeds. (*Courtburn Positioners Ltd., Kempston Hardwick, Bedford.*)

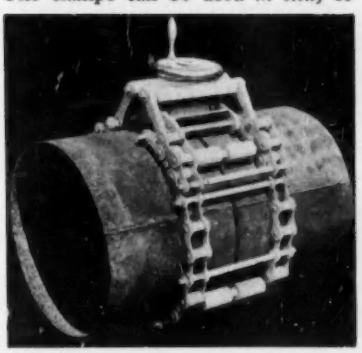


Fig. 2 (right). An example from the range of Courtburn adjustable pipe-clamps. (Courtburn Positioners Ltd.)

A smoke-density telescope

W. Ottway & Co. Ltd. are the sole manufacturers of a new and portable instrument, designed in conjunction with the fuel research station of the Department of Scientific and Industrial Research, for checking the density of smoke emissions from the chimneys of boiler plants. The instrument, known as the "Telesmoke," is a small, low-power, non-

erecting telescope which combines the image of the smoke under scrutiny with two density filters in a common plane, where they can be viewed and compared through the eyepiece. The smoke and the filters are, therefore, seen under similar conditions of magnification, light intensity and freedom from parallax distortion. The instrument is pre-set for range focus, and can be used at any distance from 50 yards upwards—the recommended range being approximately 100 yards. The only adjustment needed is for the eyepiece to be focused so that the filters are clearly defined with respect to the eyesight of the observer. The two filters, which have a density equivalent to

Fig. 3. The "Telesmoke" smoke-density telescope. (W. Ottway & Co. Ltd.)

No. 2 Ringelmann and No. 3 Ringelmann respectively, are arranged to cover half the total field of the instrument, leaving the other half free for viewing the smoke under test. (*W. Ottway & Co. Ltd., Orion Works, Ealing, W.*13.)

Induced-draught cooling tower for altitude test plant

From time to time we have published details of Fluor "Counterflo" induced-draught cooling towers installed by Head Wrightson Processes Ltd., which company are responsible for the design, supply and erection of these units, in this country and the British Commonwealth, under licence from the Fluor Products Co. of Los Angeles. The latest installation of this type, included as part of the recently commissioned Rolls-Royce aero engine altitude test plant at Sinfin "C," is capable of cooling 1.8 million gal./hr. of water through a range of 28 deg. F. The cooling water removes excess heat from six air-compressors, each rated at 22,000-h.p., and also cools the products of combustion of the aero engines under test. The tower, which is fabricated from European Redwood and Western Red Cedar, is well over 200-ft. long, 60-ft. wide and nearly 60-ft. high, consisting of six double cells, each capable of independent operation. The complete unit has twelve 20-ft. dia. fans each driven by a 50-h.p. electric motor, and the structure contains 165 standards of timber. The consultant engineers for the test plant were Messrs. Merz and McLellan. (*Head Wrightson Processes Ltd., Teesdale House, 24-26, Baltic Street, London, E.C.*1.)

Pinch valves

A new range of industrial pinch valves is now available from W. H. Rowe & Son Ltd., in sizes from 1-in. to 3-in. bore dia. Die-cast construction has been used both for the casing and internal parts and, at the same time, specially designed reinforced sleeves are used, all of which are suitable for internal pressures up to 100 lb./sq. in. The closing mechanism consists of two die-cast aluminium alloy anvils, a screwed spindle, and a handwheel which operate to compress the sleeve equally from both sides. The screwed spindle is of simple form, having two right-hand threaded portions, the lower thread being twice the pitch of the upper section. The upper fine-pitch thread engages in a robust nut which is trapped in recesses formed in each half-casing, while the lower coarse thread engages with the rising bridge which is connected by two rods to the lower anvil. In turning the handwheel clockwise to close the valve it drops towards the top of the casing by a distance equal to one-half of the valve bore, and provides a ready external indication of the position of the valve. At the same time, the coarse threaded section of the spindle causes the bridge and lower anvil to rise a similar amount to pinch the sleeve equally about its centreline. (*W. H. Rowe & Son Ltd., Quayside Road, Southampton.*)

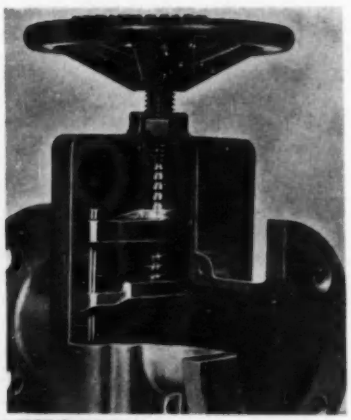


Fig. 5 (above). A 2-in. Rowe pinch-valve which is 8-in. long over the sleeve, and has a maximum height of 8½-in. from the centre of the sleeve to the top of the hand-wheel.

Fig. 4 (left). The Fluor "Counterflo" cooling - tower installation at the Rolls-Royce aero engine altitude test plant. (Head Wrightson Processes Ltd.)

Burner programming controllers

Radiovisor Parent Ltd. have produced a range of burner programming controllers for oil, gas and combination burners. Each type or equipment incorporates the appropriate form of the company's Flamestat flame-failure protection equipment. The control of "light-up" conditions is governed by the Radiovisor "brain" unit, a robust synchronous-motor, cam-operated timing arrangement with auxiliary circuit relays and over-riding thermal safety device which ensures, in operation, full conformation to the latest provisions of B.S.S. 799, 1953. Flexibility in operation is provided for in the method of cam construction, which permits a complete range of time periods to be nominated by the user together with any preferences for overlapping periods. A further feature is the provision for alternative types of housing, a non-ferrous cast drip-proof version being available, making the equipment suitable for operation under industrial conditions. The oil-burning application unit type-FF.56-SC uses a photocell unit suitable for a maximum temperature of 75 deg. C. (167 deg. F.) The FR.56-SC is the equivalent unit for gas-burning installations and employs an electrode-pattern flame detector. For combination burners, the type-FU.56-SC is recommended, the unit employing a photo-electric cell suit-

able for a maximum temperature of 55 deg. C. (131 deg. F.). In consideration of the industrial applications for the equipment, a water-cooled receiver housing has been designed specifically for use with the automatic burner control unit. A final point of interest is that the "brain" unit, type-SC, can be supplied for use with existing flame-failure protection equipments, to provide an economic form of automatic control, where conversion from manual to semi- or automatic-operation is envisaged. (*Radiovisor Parent Ltd., Stanhope Works, High Path, London, S.W.*19.)

Gas-bearing circulator

Ruston & Hornsby Ltd. announce the introduction of a new product—the gas-bearing circulator, which has been developed by the company's nuclear division and is intended for use where it is necessary to circulate gas at high-temperature and pressure without leakage. This requirement is frequently encountered in the nuclear field. In order to eliminate the need for oil bearings, the rotating assembly of the circulator is carried

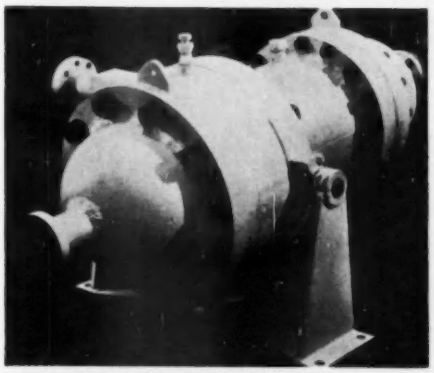


Fig. 6 (left). The Ruston & Hornsby gas-bearing circulator. (Ruston & Hornsby Ltd.)

on bearings which use the pumped gas, air, carbon dioxide or helium as a bearing fluid. The production of these bearings calls for exceptionally high standards of machining, the shaft diameter being correct to within 50 micro inches over a 5½-in. length. The capacity of the Class NFB circulator was chosen after carrying out an investigation of the probable requirements of a number of potential users, both in the United Kingdom and abroad. As produced, the unit is capable of satisfying current demands for engineering laboratory experiments and for the auxiliary circuits of large gas-cooled reactors. It can be used to circulate air, carbon dioxide or helium at all conditions up to 450 lb./sq. in. abs., and 450 deg. C., and will operate over a speed range of 10 : 1 when driven by a variable frequency a.c. supply. The gas-bearing circulator will be used in experiments within Ruston's own research centre to further the work on the design and development of nuclear power stations of 5-25-MW output. (*Ruston & Hornsby Ltd., Nuclear Division, Lincoln.*)

Metal bellows expansion joints

Samson Controls Ltd. have now made available a range of metal bellows expansion joints of an improved design. As a means of absorbing pipe expansion the Samson joint incorporates bellows made from seamless drawn tube of high copper bronze alloy, designed so that the steam, hot water or other medium flowing through the pipe-line bears only on the external surface of the metal bellows. This is achieved by the provision of an outer casing and an inner lining. Being connected at its ends to the extremities of both, thus surrounding one and being contained in the other, the metal bellows is guided in its entire length between the two, thus eliminating misalignment of the joint. The company claim that this design offers the following advantages :— Automatic centring of the metal bellows due to even external compression ; frictionless movement of the bellows as the medium being passed forms a natural cushion between the bellows and outer casing ; and the joint can be insulated in the same way as the pipe line because of its smooth and even surface. (*Samson Controls Ltd., 19, Borough High Street, London, S.E.*1.)

Re-designed condenser tube-cleaner

The Airetool Manufacturing Company has re-designed its one-man operated CC-475 condenser cleaner, for tubes up to 1-in. diameter. The CC-475 weighs only 10-lb. and can be easily operated without using any supporting rigging, the new and improved unit being operated with a single-stage geared, air-driven motor to provide all the power necessary to clean even completely plugged tubes. The motor operates at 3,800 r.p.m., and its speed is quickly and accurately controlled by a feathering valve at the handle. In operation, the motor runs quietly, and a built-in flushing system, controlled by a stainless steel sleeve valve, keeps the drill head cool and removes cuttings. The balanced design, coupled with its convenient handle and accurate trigger valve control, insures fast, easy operation with less operator fatigue. (*The Airetool Manufacturing Co., 328, S. Center Street, Springfield, Ohio, U.S.A.*)

Measuring and recording SO_2 concentrations

One of the more important substances encountered in atmospheric pollution is sulphur dioxide, which is emitted when fuels are burned. Variations in the rate of emission of

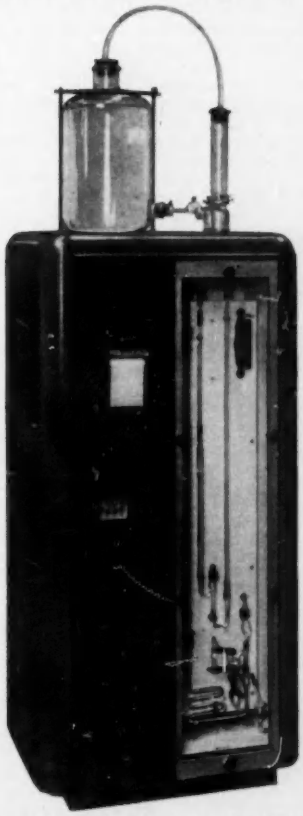


Fig. 7 (right). The Mervyn C.E.R.L. sulphur-dioxide recorder. (Mervyn Instruments.)

the gas and changes in meteorological conditions can cause the concentration of sulphur dioxide in the atmosphere at a particular point to change rapidly, and where measurement of sulphur dioxide pollution is considered, it is necessary to record not

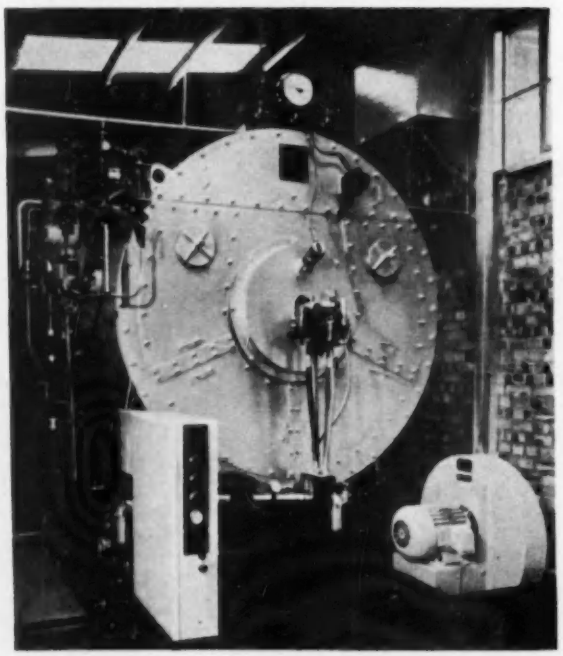
only average concentrations, but also peak concentrations. These conditions are provided for by the Mervyn-C.E.R.L. SO_2 recorder, which can measure continuously, and graphically record, such concentrations in the range of 0-50 p.p.h.m. with a sensitivity of 1 part SO_2 per 100-million parts of air, by volume. The Mervyn-C.E.R.L. is a sturdily manufactured apparatus, with dimensions of approx. 6-ft. high by 2-ft. deep. It is fully-automatic, and has a consumption of only 1-amp. on a 230-V 50 c/s, a.c. supply. It operates on the principle that SO_2 in the air is absorbed by a hydrogen peroxide reagent in a continuous counter-current absorption column; sulphuric acid forms as a result, in the reagent solution, and the recorder measures the increase in the conductivity which takes place in the reagent. (*Mervyn Instruments, Copse Road, St. John's, Woking, Surrey.*)

The estimation of chlorine residual

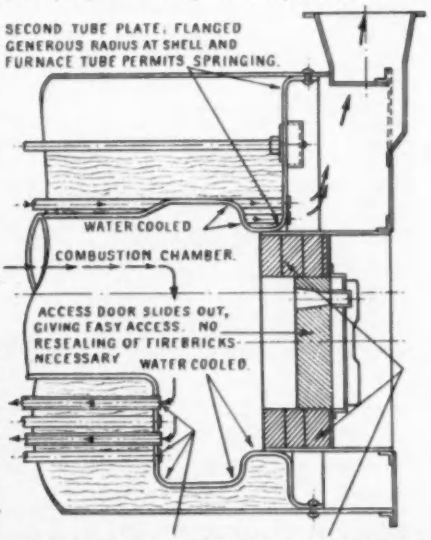
The Wallace and Tiernan Ltd. Amperometric Titrator has been developed especially for the rapid and accurate estimation of chlorine residual. With this instrument it is possible to determine the concentration of the different forms of available chlorine to within 0.01 p.p.m. Direct readings are obtained, free from interference by temperature, colour, turbidity, iron, manganese and nitrites. Simple additions of buffer solution and potassium iodide allow the determination of free chlorine, monochloramine, dichloramine and total residual chlorine in one sample. In operation the presence of free chlorine in a sample causes current to flow between two electrodes, as indicated by a sensitive microammeter. Phenylarsene oxide is added from a microburette until the current falls to a point where no further change is observed. The mono- and di-chloramine fractions are determined in the presence of suitable concentrations of potassium iodide and buffer solution, the liberated iodine being titrated against phenylarsene oxide. The Amperometric Titrator is mounted in a convenient and portable housing, suitable for either laboratory or plant use. (*Wallace & Tiernan Ltd., Power Road, W.4.*)

A NEW PACKAGED BOILER

A new range of "packaged" boilers, known as the "Steampacket," with capacities from 1,010 to 10,500 lb./hr. is announced by The Cradley Boiler Co. Ltd. They are three-pass horizontal boilers of semi-wetback construction, having two independent rear tubeplates, the first of which receives the high-temperature gases leaving the furnace, whilst the second is contacted by the cooler outgoing gases. This is claimed to eliminate any risk of damage by overheating or uneven heating of the rear tubeplate and combustion chamber, while at the same time ensuring that an increased proportion of the hotter gases is contained within the water-space to give maximum efficiency. There are comparatively few firebricks in the rear, or combustion chamber, and the cooling effect of the semi-wetback is said to ensure many years of life without replacements. Furthermore, plain tubes can be expanded in, in the ordinary way, welding being unnecessary; and they can thus be easily replaced or re-expanded if required. The boiler is of part riveted and part welded construction, with the tubeplates flanged, a design feature, which by making the unit less rigid, enables steam to be raised very rapidly from cold without risk of damage. A medium pressure air-type burner of the fully-automatic "high/low/off" type is provided. Its two-stage action for mixing and swirling of the oil-fuel and air provides a powerful atomisation with good flame stability and efficient combustion. The air is pre-heated at the boiler face before it is passed to the combustion zone. The control system is simple, and the components which require periodical maintenance are easily accessible. The burner itself can also be easily removed for inspection and cleaning, merely by unscrewing one wing bolt, and the electrode ignition assembly can be removed by turning a cam lever. The unit incorporates primary and secondary low-water cut-offs, while the burner is also cut off through the medium of a photo-electric cell if the flame should fail, and by a pressure-switch should the draught fail or fall below a predetermined level. A high steam cut-off is also provided by means of another pressure-switch which shuts off the burner when a pre-set pressure is reached, and relights it automatically when pressure falls again. In addition, a special anti-shock device, known as "Grad-U-Start," eliminates blow-back on lighting-up. The "Steampacket" is claimed to have an efficiency of over 80 per cent., and to combine a flexibility of operation, responding well to fluctuating loads, with economy and compact dimensions.



(Left). The P.11 model from the range of "Steampacket" packaged boilers. This unit has an evaporative capacity of 4,800 lb./hr. from and at 212 deg. F.


SECOND TUBE PLATE; FLANGED GENEROUS RADIUS AT SHELL AND FURNACE TUBE PERMITS SPRINGING.
WATER COOLED
COMBUSTION CHAMBER.
ACCESS DOOR SLIDES OUT, GIVING EASY ACCESS. NO RESEALING OF FIREBRICKS NECESSARY
WATER COOLED
FIRST TUBE PLATE; FLANGED AT CIRCUMFENCE AND AT FURNACE TUBE PERMITS SPRINGING.
PERMANENT REFRACTORY SEAL BETWEEN HIGHEST AND LOWEST TEMPERATURES.

(Right). Diagrammatic arrangement of "Steampacket" boiler, showing two rear tubeplates.

OVERSEAS Steam Engineering Practice

Abridgments of recent articles in the colonial and foreign technical press, concerning design and progress in the technique of steam generation and power plant equipment

German plant for 4,260 lb./sq. in. and 1,112 deg. F. steam

The latest boiler to be constructed for a large industrial power plant in Germany is shown in Fig. 1. This is of the Benson once-through type, and produces 550,000 lb. of steam per hour at 4,260 lb./sq. in. and 1,112 deg. F. final temperature. Of a total of 79,223 sq. ft. (7,360 sq. m.) heating surface 25,123 sq. ft. (2,334 sq. m.), i.e., 32 per cent., are made of austenitic material. The austenitic tubing of 27 mm. o.d. varies in thickness from 3.5 to 5.75 mm. In view of the high operating pressure, the use of ferritic tubing is confined to boiler parts in which the metal temperature of the tubing does not exceed 968 deg. F., corresponding to a steam temperature of 896 deg. F. All parts of the boiler exposed to metal temperatures in excess of 1,031 deg. F. are made of precipitation hardening steel containing < 0.1 per cent. C, 16 per cent. Cr, 13 per cent. Ni, 1.1-1.5 per cent. Mo, 0.6-0.8 per cent. V, 0.1 per cent. N and Nb > 10 × C per cent. + 0.4 per cent. Heat-treatment consisted of heating at 1,382 deg. F. for five hours. All tubing of 27 mm. to 70 mm. o.d. was cold-bent and not heat-treated after bending, but cold-bent or welded parts of larger diameter were locally treated at 1,472 deg. F. for not longer than 1½ hr. The bends of the live steam piping of 121 mm. o.d. and 22 mm. wall thickness made of the aforementioned austenitic steel were fabricated at 1,472 deg. F., fabrication time per bend not exceeding one hour. This made it possible to dispense with a subsequent heat-treatment which, because of the weight and dimensions of the piping, would have been difficult to carry out. The boiler is equipped with steam temperature control by water injection in two stages. The first (main) stage injection is placed still in the ferritic part but immediately before the austenitic part, while the second injection takes place in front of the final superheater stage. The first injection is actuated by a signal derived from the steam temperature prevailing after this stage and a correcting signal derived from the quantity of water injected in the second stage. The correcting signal serves to minimise temperature fluctuations at the point of second injection, so that the rate of steam temperature variation at this point does not exceed 5.4 deg. F./min. The first reheater is of the radiant type and the second reheater is of the convection type. The high-pressure turbine of the reaction-type designed for 4,260 lb./sq. in. pressure and 1,112 deg. F. steam temperature at the throttle (Fig. 2) is rated at 16-MW. Inner casing and shaft are made of 12 per cent. Cr steel. The shaft sleeve carrying the first ten stages is made of austenitic material. On the operational side it is reported that faulty operation of

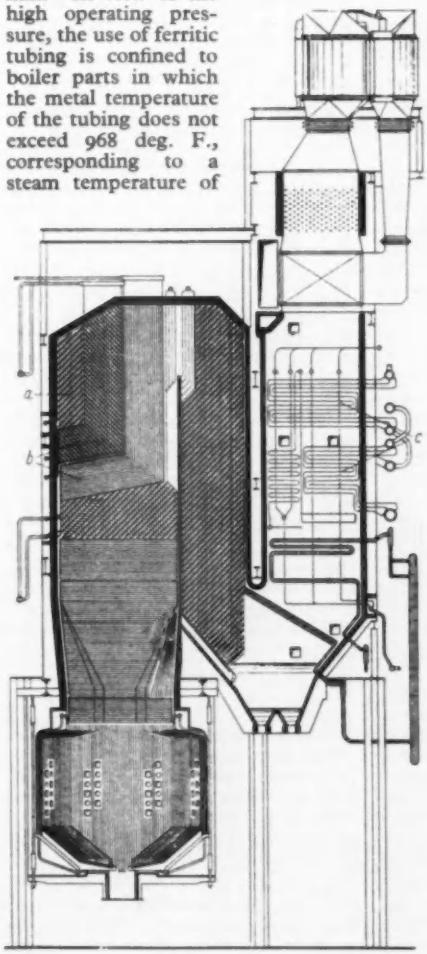


Fig. 1 (left). Sectional arrangement of a Benson once-through type boiler with an evaporative capacity of 550,000 lb./hr., at 4,260 lb./sq. in. and 1,112 deg. F. Key:—(a) Live steam superheater; (b) first reheater; (c) second reheater.

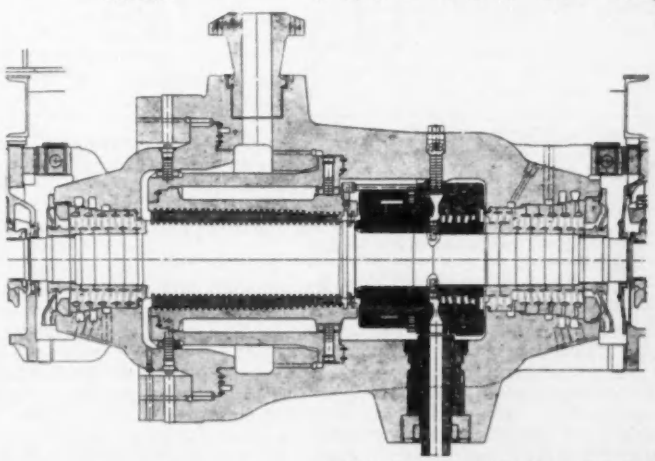


Fig. 2 (below). Sectional arrangement of 16-MW. high-pressure turbine, designed for steam conditions of 4,260 lb./sq. in., and 1,112 deg. F.

the feedwater make-up plant resulted in considerable damage to the boiler tubing by stress corrosion. It is pointed out that the damage was confined to parts of the tubing where the material carried internal stresses in addition to the operational stress. (*G. Noetzlin and A. Engl, BWK*, October, 1958, pp. 481-487.)

Flame-photometry as a guide to boiler water purity

Investigations have shown that conductivity measurements as an index of steam and water purity are often unreliable under 5 micromhos and invalid under 1 micromho. Other studies have shown that in certain cases such techniques as sodium flame-photometry and the use of radioactive tracers produce results that can be correlated with the performance of modern high-pressure boilers, evaporators, etc. The authors of a paper presented recently to the American Power Conference 20th anniversary meeting, describe the development of a successful automatic sodium - flame photometer analyser and recorder. They discuss means of eliminating interferences such as " dark current " and noise, and present information on improved burner, photomultiplier and electronic circuits for the unit. A novel means of rapid field calibration by means of light emitted by dry flame is a feature of the instrument, and the paper also gives plant applications showing the instrument's adaptability where more conventional test methods are unsatisfactory. The authors conclude that the continuous recording sodium-flame photometer is a successful operating instrument of high sensitivity. The established capability of the instrument makes it suitable for monitoring condensate at nuclear power plants, and other uses are being developed, some of which are mentioned in the paper. Only one experimental model has been built to date. (*American Power Conference, 20th Anniversary Meeting.*)

Single-pass counter-flow condenser

The larger turbine capabilities required by central steam stations have led more and more to the design of turbines with twin low-pressure ends and, hence, dual exhausts. To accommodate these exhausts, plant layouts have been made both with twin-shell condensers having tubes running at right angles to the centre-line of the two exhausts and single-shell condensers having very long tubes running parallel with the centre-line of the exhausts. Alabama Power Co. were recently faced with this problem in the laying out of a plant extension for the Barry Station Unit No. 3. The problem was further compounded by the requirement of a backwashing system which had to be incorporated in the condenser. It became apparent to the engineers that a tandem shell arrangement adaptable to the use of a counter-flow circulating-water system would provide a novel and effective solution to this and to several other problems associated with twin exhaust turbine arrangements. This allowed for a simple but effective backwashing arrangement, which was incorporated in the design. The total cooling surface of the Barry Station condenser is 150,000 sq. ft. It has 23,876 tubes, 1-in. in dia., with an effective length of 24-ft. The condenser is designed to maintain 1.92 in. Hg. back-pressure when condensing 1,100,000 lb./hr. of steam from a 225-MW turbine, and when supplied with 160,000 gal./min. of 80 deg. F. water with a cleanliness factor of 85 per cent. The condenser sections are of standard Foster Wheeler double-flow design. The auxiliary equipment supplied with the condenser consists mainly of two vertical mixed-flow type Foster Wheeler circulating water pumps with removable rotating elements, each designed for 80,000 gal./min. at 20-ft. total dynamic head with an efficiency of 83.5 per cent., operating at 252 r.p.m., the pumps being 31-ft. 11-in. long, with a 94-in. dia. suction bell and a 66-in. dia. discharge ; three horizontal five-stage, double suction Foster Wheeler condensate pumps, each designed to pump 1,500 gal./min. of condensate at 565-ft. total dynamic head, with operating speed of 1,170 r.p.m. and efficiency of 72 per cent., Kingsbury type thrust bearings being incorporated in the design ; and two piston-type dry-vacuum pumps with displacements of 1,342 cu. ft./min. to be used as main air evacuation equipment for the condenser. The condenser is arranged so that each shell is fixed under the centre-line of one of the turbine exhausts. Each of the condenser exhaust necks is connected to the turbine exhausts through single bellows stainless steel expansion joints, designed and built by Foster Wheeler as integral parts of the condenser and exhaust neck extension piece. These joints are designed to impose a minimum variation in loads on the turbine exhaust nozzle as vertical dimensions are changed by thermal expansion in the condenser shell. Since each of the two condenser shells is fixed beneath its individual turbine exhaust, moulded rubber expansion joints had to be incorporated in the assembly of the centre waterboxes to provide a means for absorbing thermal expansion in the horizontal direction between the two fixed axes. These expansion joints are on the water side of the condensing system and therefore not subject to extreme vacuum loads or elevated temperatures. To further compensate for horizontal thermal expansion, Foster Wheeler stainless-steel expansion joints were included in the two 60-in. steam-side pressure equalising lines located between the condenser exhaust necks. A secondary use for the equalising ducts was realised by passing through these openings many of the pipelines that must cross-connect one turbine exhaust section to the other. This, also, was the case with certain of the large steam extraction lines that pass from the low-pressure end of the turbine, as well as some air offtake piping connecting the condenser air coolers. The circulating water pumps are placed within the station itself. One is located at each end of the condenser to allow the circulating water to be pumped directly into the counter-flow condenser. This also permits various modes of operation with a minimum of piping and valves at the condenser floor level. To accommodate low-head, high-capacity requirements a pump of high specific speed had to be selected. This, therefore, meant that a fairly high submergence, or net positive suction head was needed. Since these pumps are located, with their suction bells submerged, in pits beneath the condenser floor level, it was imperative that the dimensions of the pits be kept at a minimum to facilitate their location without interfering with building footings and piers. For this reason, narrow pits were used with turning vanes to guide the flow of the incoming water directly into the suction bell of the pumps. Since the condenser is of the rectangular double-flow design, a minimum of vertical clearance was required for its installation. This permitted the use of horizontal condensate pumps, with their many inherent advantages, without necessitating pits. (*Heat Engineering*, Vol. 33, No. 3, pp. 141/143.)

375-MW power station for aluminium plant

A new power station, with a design capacity of 375-MW, is now being constructed at the Aluminium Co. of America, Warwick Works, adjacent to the Ohio river near Evansville. The plant will comprise three 125-MW tandem-compound, double-flow turbo-alternators, which are to be supplied with steam from three

boilers, each rated at 1-million lb./hr. at 1,975 lb./sq. in. and 1,005 deg. F., with reheat to 1,005 deg. F. The boiler furnaces will be fired by pulverised coal, and four pulverising mills associated with each unit will serve sixteen burners mounted in the front furnace wall. Steam temperature control will be by spray attemperation, and gas recirculation. Exit gases will pass through air-preheaters (two per unit), and mechanical dust-collectors (three per unit). A feature of the installation will be what is referred to as the "maximum economic" use of aluminium. For example, each unit is to be provided with a 60,000-gal. capacity aluminium condensate storage-tank; two of the three l.p. feedwater heaters serving each unit will have aluminium tubes; and the condensers, of the single-shell, two-pass, divided water-box type, each with a cooling surface of 75,000 sq. ft., will incorporate aluminium tubes in steel tube-sheets. (*Power*, Vol. 102, No. 10, pp. 78/81.)

Three of the member companies of **The Darlington Group of Companies,** exhibiting on the group stand at the Brussels International Exhibition, have between them won no less than nine awards—including two of the six Diplomas of Honour awarded to British firms. The three companies are The Darlington Insulation Co. Ltd., The Chemical & Insulating Co. Ltd., and The British Refrasil Co. Ltd. The Darlington Insulation Co. Ltd. won awards in every field in which they work. For their thermal and acoustic insulation work they have received a Diploma of Honour, while their work on nuclear and conventional power stations has brought them two silver medals, for their contributions to nuclear energy exploitation and to electrical power production. For their work in the oil refining and shipbuilding industries they receive two bronze medals. The Chemical & Insulating Co. Ltd., the main manufacturing member of the group, specialising in the production from dolomite limestone of magnesium carbonate, oxide and hydroxide, received a silver medal for its inorganic chemicals and a bronze medal for its pharmaceutical products. The British Refrasil Co. Ltd., who produce "Refrasil"— a silica fibre with high-temperature thermal and electrical insulating properties, received a bronze medal, for work in the field of aircraft construction, while their contribution to the application of electrical energy to industry won a Diploma of Honour.

* * *

Along with the **British Thomson-Houston Export Company,** who are the main contractors, and the civil engineering contractors—Balfour Beatty & Co. Ltd.—John Thompson Water Tube Boilers Limited, Wolverhampton, share in a £2¼ million contract for the building of Fuerzas Electricas de Cataluna S.A.'s new 60-MW power station, at Mata, Barcelona, Spain. Under penalty if not completed within twenty-two months, the contract was won in the face of very keen foreign competition. John Thompson's share of the work is estimated to be worth something in the region of £1 million, and will include the boilerhouse building, the oil-fired boiler and its auxiliaries, and the steam piping. They will also be responsible for the erection of the plant, and for its commissioning. The boiler will have an m.c.r. of 550,000 lb./hr., at a working pressure of 950 lb./sq. in. and final steam temperature of 915 deg. F. Heating surface of the boiler will be 7,850 sq. ft.; of the economiser, 27,100 sq. ft. and of the air-heater, 64,600 sq. ft. John Thompson-Kennicott Limited are to supply the water-treatment plant and the feed dosing equipment.

Consolidating their venture into the South African market made early in 1956, **Birlec Limited** has opened a Johannesburg branch office, under the management of **Mr. S. G. King.** Situated between Boksburg and Benoni, the new branch will deal with all enquiries, including project design and engineering service work. The postal address is P.O. Box 99 Witfield, Transvaal. In November, 1955, Mr. King, formerly manager of Birlec's London office, established an office in Johannesburg. There he acted in an advisory capacity to the B.T.H. Company (S.A.) Pty. Limited who, for the interim period, were agents on behalf of Birlec. It is expected that the chief demand will be for melting furnaces, particularly for those used mainly in making alloy steels. While certain special equipment and parts will continue to be imported from the main Birmingham works of Birlec Ltd., the majority of the equipment will be manufactured locally by the Firlst Electro Corporation. In the Federation of Rhodesia and Nyasaland the British Thomson-Houston Company (Central Africa) (Pty.) Limited will continue to act as Birlec agents, but the services of the new branch will now be fully available to Birlec furnace users in the Federation, particularly for technical advice and assistance when required.

* * *

The Cape Asbestos Co. Ltd. announce the acquisition of the whole of the share capital of Consolidated Blue Asbestos Corporation (Pty.) Ltd., a compnay with blue asbestos mines in Cape Province, South Africa, between Kuruman and Postmasburg. This will not only provide Cape Asbestos with additional asbestos fibre but considerably strengthen their fibre reserves. Cape Asbestos claim to be the largest producers in the world of blue crocidolite asbestos. Through their subsidiary Cape Blue Mines (Pty.) Ltd., they operate blue asbestos mines at Koegas and Westerberg beside the Orange River in Cape Province, at Pomfret on the border of Bechuanaland, and at Malips Drift in the Transvaal. Cape Blue asbestos is used for spinning and weaving into asbestos yarns, cloths and packings; as a filler in the rubber and plastic industries for products which are resistant to heat, acids and corrosion, such as battery boxes; and in the manufacture of asbestos-cement products.

* * *

Dewrance & Company Limited announce the termination of their agency agreement with **Burke & Son Ltd.,** Belfast. Their sole representative for Northern Ireland is now **Mr. Duffin McNeice,** 87, Rochester Avenue, Cregagh, Belfast (Belfast 48823).

MOND NICKEL FILMS

Two films, one of them new, and the other revised and brought up-to-date, were shown for the first time in London recently by the Mond Nickel Co. Ltd. The first, entitled "Nickel Alloy Permanent Magnets," aims to demonstrate the properties of nickel alloys for permanent magnets, with particular reference to their stability and strength, and surveys some of the latest mechanical and electrical developments which have been facilitated by these materials. The introduction to the film reviews the well-known properties of magnets, and goes on to show the striking increase in the power of magnet materials developed during the past sixty years. The very high stability of nickel-containing magnets is demonstrated by subjecting an Alcomax magnet to extremes of heat, cold and vibration. Sequences include the manufacture of magnets, electrical and mechanical applications in industry. The film ends with shots showing some of the present-day uses of nickel alloys in laboratory standards and nuclear resonance magnets. Produced in the studios of the Mond Nickel Company Limited, the film is a 750 ft., 16 mm. sound and colour production, and runs for 21 min. The second film entitled "Spheroidal Graphite Cast-Iron," revises and brings up-to-date the first Mond-Nickel film on S.G. iron, and demonstrates how altering the shape of the graphite in cast-iron confers upon it unusual properties of strength and ductility. Opening with a brief resume of the advantages and limitations of ordinary cast-iron, the film shows how, with the alteration of graphite shape, S.G. iron takes on some of the properties of steel, while retaining its castability. Reference is made to S.G. Ni-Resist, a high-expansion, non-magnetic alloy, which is even more ductile than other S.G. irons, and is resistant to heat and corrosion. The two main types of S.G. iron—Ferritic and Pearlitic—are explained with graphs illustrating their stress strain curves. The remarkable ductility of the material in the annealed state is demonstrated and yet S.G. iron is seen to be stiffer than ordinary cast-iron. Resistance to impact and twisting, machinability, and the versatility of the material in up-to-date applications are illustrated. The film, like that mentioned above, was produced in the studios of the Mond Nickel Company Limited, and is a 1,000-ft. 16 mm. sound and colour production and runs for 28 min. The films are available on free loan to interested persons and organisations on application to:—The Publicity Department, The Mond Nickel Company Limited, Thames House, Millbank, London, S.W.1.

Latest Power Plant Patents

These extracts from British Patent Specifications are reproduced by permission of The Controller of H.M. Stationery Office. (Complete British Specifications can be obtained from the Patent Office, 26, Southampton Buildings, London, W.C.2. Price 3s. 6d. each, both inland and abroad.)

Pressure-fired vapour generator

The pressure-fired boiler shown diagrammatically in Fig. 1 includes a horizontal steam and water drum (13) above an upright cylindrical shell (14) which forms the pressure casing within which is a concentric metal baffle (15) surrounding a combustion chamber (16). The latter has a refractory floor (17) spaced from the lower edge of the baffle (15). A circumferential row (18) of substantially vertical water-tubes (19) lines the inner surface of the baffle (15). A second row (20) of water-tubes is arranged concentrically within the row (18), the tubes of which row partly accommodate the tubes of the row (20) between them. The tubes (19) are bent towards the axis of the combustion chamber (16) near their top ends, and then out towards an upper circular outlet header (21) into which they are connected. The header (21) is rectangular in transverse cross-section. The lower parts of the tubes (19) are inclined toward the axis of the combustion chamber for a short distance, and then resume their vertical run. The lower ends of the tubes (19) are connected into circular header (22). The lower parts of tubes (19) are spaced apart in order to provide a gas outlet (23) for combustion gases to leave the combustion chamber (16.) Three burners (24) at the top of casing (14) fire down into the chamber (16). A second circular baffle (26) is arranged in the casing (14), concentric with the baffle (25) with which it defines an annular gas passage (27). A vertical bank of water-tubes (29) is arranged in the passage (27) in circular rows concentric with the baffles (15 and 26). The upper ends of the tubes (29) are connected into the header (21) while the lower parts, at about the level of the lower edge of the baffle (15), are slightly inclined outwards and then resume their vertical run across the gas outlet (23). The lower ends of the tubes (29) are connected into a circular inlet-header (30), rectangular in cross-section, and concentric with the inlet header (22). The lower parts of the tubes (19 and 29) define between them an annular space (31) which connects the combustion chamber (16) with the annular gas-passage (27) in order to provide for the passage of combustion gases. Combustion gases in the passage (27) are discharged from the boiler by a port (32) in the shell (14). In the space (31), which is traversed by combustion gases flowing from the chamber (16) to the gas passage (27), is a superheater (34) which comprises an annular bank of sixteen horizontal layers (not shown) of superheater tubes ; each layer consisting of three circular tubes (not shown). Should any superheater tube fail or need attention, the closure plate (60) may be removed, and the entire superheater assembly (34) may be moved downwards out of the boiler casing (14). *British Patent No.* 801,768 *issued to Foster Wheeler Ltd. Complete specification published September 24th*, 1958.

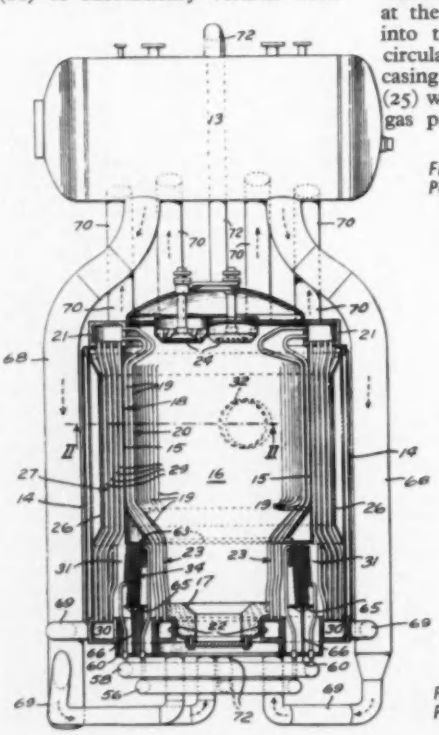


Fig. 1 (left). British Patent No. 801,768.

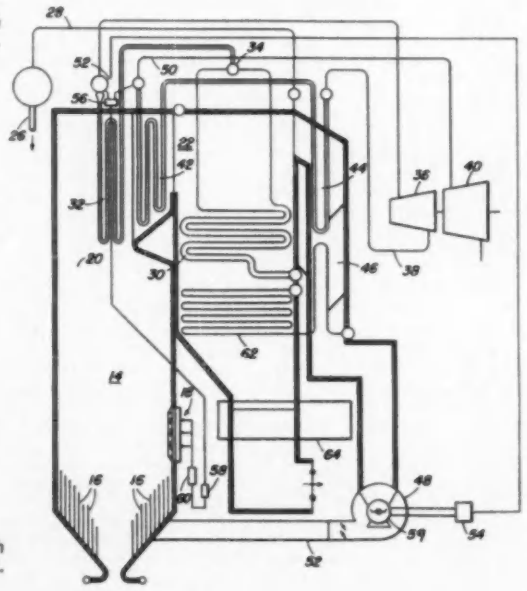


Fig. 2 (right). British Patent No. 802,032.

Steam generator with controlled superheat and reheat steam temperature

Fig. 2 shows a steam generator which comprises a furnace (14), the inner face of the walls of which

are lined with steam generating tubes (16) and into which a suitable fuel such as oil, pulverised coal, or gas, together with the combustion air, is introduced through burners (18). The combustion gases pass upwards through the furnace, and leave through outlet (20) into gas-pass (22) through which they are conveyed to a chimney. The superheater is of conventional design and is divided into a low-temperature section (30) and a high-temperature section (32), both of which are arranged within passageway (22), so that the gases leaving furnace (22) traverse these superheater sections and impart heat to the steam. The saturated steam in pipe (28) is first passed through the low-temperature section (30) after which it is collected in header (34) and then passed through the high-temperature section (32). From this high-temperature section the superheated steam is conveyed to the high-pressure stage (36) of the turbine, and after passing through this high-pressure turbine it is returned through pipe (38) to the boiler for reheating before being introduced into the low-pressure stage (40) of the turbine. The reheater through which this returned steam is conveyed and reheated to the desired temperature is divided into two sections, with the main reheater section (42) being placed in passageway (22) between the high-temperature and low-temperature superheater sections, and with the supplemental or auxiliary reheater section (44) connected in series with section (42). Section (44) is arranged in duct (46) which communicates with passageway (22) at a location between reheater section (42) and low-temperature superheater section (30). Duct (46) is thus in bypass relation with the low-temperature superheater section (30), and the outlet of this duct leads to an inlet of fan (48) which is driven by a variable-speed motor (59) with the outlet of the fan communicating with the lower end of furnace (14) through duct (52). Thus, fan (48) is effective to recirculate combustion gases from passageway (22) back into furnace (14) for the purpose of controlling steam temperature in a well-known manner with the gases thus recirculated, bypassing the low-temperature superheater section (30) and being conveyed over auxiliary reheater section (44). After the steam to be reheated has passed through reheater sections (42 and 44) it is conveyed through pipe (50) to the low-pressure stage (40) of the turbine, after which it passes through a condenser. The various superheater and reheater surfaces may be proportioned in such a manner that both the superheated and reheated steam temperatures may be maintained at their desired value solely by the gas recirculation control. However, since it may be difficult, if not impracticable, to precisely calculate and design these surfaces for this result, and since the heat-exchange characteristic of the various surfaces may vary during operation because of deposits forming on the surfaces, it may be desirable to provide a form of control in addition to the gas recirculation control. For this purpose, the burners (18) may be made of the tilting type so that the zone of combustion may be moved longitudinally in the furnace towards and away from furnace outlet (20). *British Patent No.* 802,032 *issued to Combustion Engineering Inc. Complete specification published September* 14*th*, 1958.

Nuclear reactor with steam generator

This invention relates to steam generators working in conjunction with nuclear reactors, a gaseous coolant circulating in closed-circuit in heat-exchange relationship with the reactor, and a heat-exchanger. At the present time a steam generator of the type used in power station practice comprises a reactor shell containing the reactor, and a number of vessels each containing a heat-exchanger for the generation of steam. The heat-exchanger is connected with the reactor shell by ducting for the circulation of the coolant medium, the ducting being provided with shut-off valves and with expansion joints so as to accommodate the considerable thermal expansion and contraction of the ducting which occurs in service. The reactor shell is supported on a seat of such design as to permit expansion and contraction of the shell. It is surrounded by a thick concrete wall serving as a biological shield, while the heat-exchanger vessels are distributed

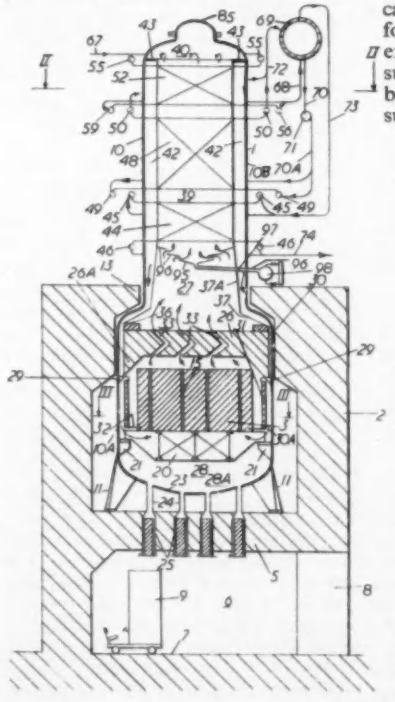


Fig. 3 (left). *British Patent No.* 803,382.

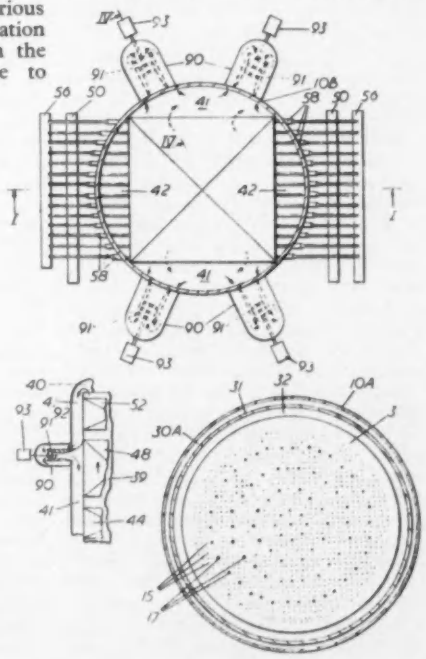


Fig. 4 (top, right).

Fig. 5 (centre, right).

Fig. 6 (bottom, right). *British Patent No.* 803,382.

around the building housing the reactor shell. The area occupied by the vapour generating section of the power station is considerable and the cost of buildings and components is high, whilst extensive site welding of the ducting introduces leakage hazards. According to the invention the reactor, the circuit for the gaseous coolant, and the heat-exchanger are contained within a common pressure vessel. Referring to Figs. 3-6, the steam generator (1) is supported by a massive concrete structure (2), part of which serves as a biological shield for a nuclear reactor (3). The steam generator (1) includes a vertically extending pressure vessel (10) which is for the most part of circular cross-section, and the lower part (10A) of which is of larger diameter than the coaxial upper part (10B). In a lower part of the gas-pass (39) is a tubular convection superheater (44) consisting of a bank of tubes each connected at an upper end to one of two inlet headers (45), extending as a number of superimposed straight tube lengths, connected in series by return bends, to and fro across the gas pass (39), and connected at its lower end to one of two outlet headers (46). Within the gas pass (39) above the superheater (44) is a tubular steam generating section (48) consisting of a bank of tubes each connected at its lower end to one of two inlet headers (49), extending as a number of superimposed straight tube lengths, connected in series by return bends, to and fro across the gas pass (39), and connected at its upper end to one of two outlet headers (50). Within an upper part of the gas-pass (39) is an economiser (52) consisting of a bank of tubes each connected at its upper end to one of two inlet headers (55), extending as a number of superimposed straight tube lengths, connected in series by return bends, to and fro across the gas-pass (39), and connected at its lower end to one of two outlet headers (56). The end parts of all these heat-exchanger tubes pass by way of suitable thermal sleeves such as the sleeve (58) (shown in Fig. 4) through the pressure vessel wall. A feed-water pipe (67) is connected to the economiser inlet headers (55); transfer pipes (68) connect the economiser outlet headers (56) to the water space of a steam and water drum (69) which is located above the level of the economiser; the water space of the drum is connected by pipe (70); circulating pump (71) and pipes (70A) are connected to the inlet headers (49) of the steam generating section (48). The outlet headers (50) are connected by pipes (72) to the steam space of the drum. Pipes (73) connect the steam space of the drum to the inlet headers (45) of the superheater, and pipes (74) connect the superheater outlet header (46) to a steam main leading to the point of use of the superheated steam. Below the superheater (44) is a central condensate collecting tray (95), above which are placed annular, downwardly dished, overlapping baffles (96) which effectively intercept condensate drips falling in the gas-pass (39) from any part of the heat-exchange surfaces. The lowest point in the tray (95) is connected by a drainage pipe (97) to a collecting header (98) outside the pressure vessel. The space within the pressure vessel (10) is filled with the gaseous coolant, carbon dioxide, under a suitable pressure—for example, a pressure of 150 lb./sq. in., under static conditions when the reactor is non-critical; the gas temperature is 20 deg. C. *British Patent No.* 803,382 *issued to Babcock & Wilcox Ltd. Complete specification published October 22nd,* 1958.

Tubular heat exchanger

This invention relates to heat-exchangers of the type in which a high-temperature fluid passes through the space between a pair of concentric tubes, and a low-temperature fluid flows over the outer and through the inner tube. The heat-exchanger element as shown in Figs. 7-10 comprises a double-walled tube with concentric tubes (1 and 2) spaced to form a water-jacket (3). Concentric with the tubes (1 and 2) is an inner tube (4). An admission nozzle (5) (Fig. 7a) has a central end for connection to a cooling-water supply tube (6), an axial tubular connection (7) to the inner tube (4), and four inclined radial tubular connecting passages (8) opening so as to connect with the jacket space (3) through a circular skirt (9) which is welded to the relatively longer and shorter ends of the tubes (1 and 2). Radial openings (10) (Fig. 8) are left in the nozzle to permit the entry or discharge of hot gases, as indicated by arrows (*A*) in Fig. 7a, into or from the annular space (11) between the tubes (2 and 4). A discharge nozzle (12) (Fig. 7b) comprises a chamber (13) substantially conical in diametrical section and a base (14) of a diameter equal to the external diameter of the tube (1). The base (14) has its outer, inward periphery welded at (15) to the end of the tube (1), and a circular skirt (16) welded to the somewhat shorter end of the tube (2). The end of the inner tube (4) passes through the base (14), and the latter presents adjacent its periphery four longitudinal passages (17) between which are disposed four openings (18). The passages (17) connect the water-jacket space (3) with the chamber (13) in the nozzle (12), and the openings (18) are for discharge or entry of gases from or into the annular space (11) as indicated by arrows (*B*) in Fig. 7b. Four equiangularly spaced long-pitch helical fins (19) are secured to the inner tube (4). The outside diameter of these helical fins is slightly less than the inside diameter of the tube (2), as seen in Fig. 9, so as to leave a continuous narrow gap between the outer edge of each fin and the inner surface of the tube (2). The number of fins may be less or more than four in number, as may be found suitable.

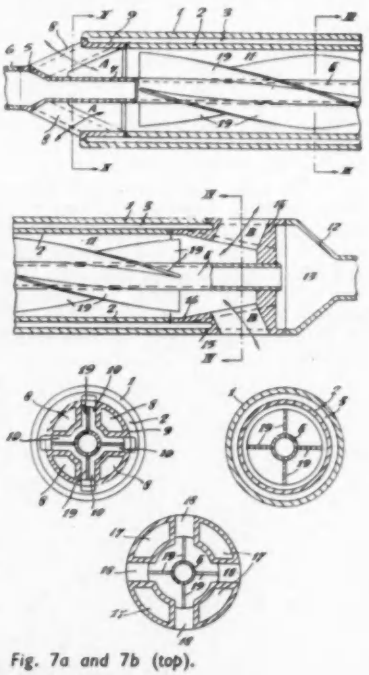


Fig. 7a and 7b (top).
Fig. 8 (centre, left).
Fig. 9 (centre right).
Fig. 10 (bottom). British Patent No. 803,491.

In use, a number of these heat-exchanger elements may be mounted in a parallel relationship in a chamber to form a heat-exchanger through which hot gases are passed under pressure, the gases surrounding the water-jacket tubes (1), and also passing through the annular spaces (11). Water under pressure is simultaneously passed through the water jackets (3) and central tubes of the elements, from and to headers to which supply tubes (6) and discharge nozzles (12) are connected. These elements provide a large heating

surface per foot of run of tube, all surfaces in contact with the gases being heat-absorbing surfaces. The heat-transfer ratio between gas and liquid is accurately determined by the cross-sectional area of the annulus which meters the gas flow. The fins (19) are welded on to the inner water tubes (4), and therefore produce a rotary motion in the gases passing through the annular spaces within the water-jacket tubes. Leakage from the spiral streams of gas occurs through the gaps between the outer edges of the fins (19) and the inner surfaces of the water-jacket tubes (2), thereby producing a scrubbing effect and a correspondingly higher heat transfer ratio at these places. Both the gas flow and the water flow pass through nozzles which themselves also provide a certain amount of heat transfer surface. *British Patent No.* 803,491 *issued to Clarke, Chapman and Co. Ltd. Complete specification published October 29th,* 1958.

George Kent Ltd. announce the recent appointment to the board of their Belgian subsidiary company, Kent-Continental S.A., of **Mr. F. J. Havenith** as local resident director. Mr. Havenith has been the manager, first of Kent's Brussels office, and subsequently of the Belgian company, since its formation. In addition to his work in the Belgian market, Mr. Havenith has direct supervision of Kent offices and activities in Germany and Holland and is working in close contact with the agents in Switzerland, Messrs. Socsil of Lausanne.

* * *

It is with regret that we record the sudden death recently of **Mr. Cecil C. Mason,** O.B.E., who was a director of the Cambridge Instrument Company Limited. Mr. Mason was joint managing director of the company from 1910 until his retirement from executive work in 1941, after which he remained as a member of the board until his death.

* * *

The Joint Symposium on Instrumentation and Computation in Process Development and Plant Design organised by the Institution of Chemical Engineers, The Society of Instrument Technology and the British Computer Society is to be held at the Central Hall, Westminster, S.W.1, on May 11th to the 13th, 1959, and not during April, as originally stated. Enquiries should be made to the **Institution of Chemical Engineers,** 16, Belgrave Square, London, S.W.1.

* * *

Keith Blackman Ltd. have sent us a copy of their new publication (No. 41) entitled "Small fans and blowers." This publication gives technical information regarding various units of the range of "Tornado" small fans and blowers. Duty range and specification details for the various units are given.

* * *

W. C. Holmes and Co. Ltd., Huddersfield, have issued a new publication (No. 75) dealing with the Type XAS Holmes Connersville Exhausters and Boosters. The publication gives details of design, principle of operation, installation instructions, and in tabular form, pressure ranges and dimensions.

* * *

It is with much regret that we record the sudden death, on November 4th, 1958, of **Mr. A. S. Dodds,** director and London manager of John Thompson Water Tube Boilers Ltd. Mr. Dodds, joined the John Thompson Group seven years ago, from Messrs. Merz and McLellan with whom he was senior engineer at Newcastle upon Tyne. When, in 1957, Mr. C. J. Howard moved to Wolverhampton to become managing director of John Thompson Water Tube Boilers Ltd., Mr. Dodds succeeded him as manager of their London office.

The licensees for the design, construction and installation of Siemens-Schuckertwerke once-through, forced-circulation boilers, for Great Britain and the British Commonwealth are **Simon-Carves Ltd.,** Cheadle Heath, Stockport, Cheshire. O.T. boilers can be designed and built for operation at pressures up to the order of 5,000 lb./sq. in. and with steaming capacities suitable for any purposes from small industrial plants to large central power stations. Information relating to this type of unit is contained in a new 14-page brochure, published recently by Simon-Carves Ltd.

* * *

Elliott Bros. (London) Ltd., a member of the Elliott-Automation Group, has been awarded a contract by the Central Electricity Generating Board for the design and manufacture of a nuclear power station simulator. The simulator will be used for training operators for the Berkeley and Bradwell power stations, and for subsequent stations of a similar type. It consists, in effect, of a replica of the main control desk and will simulate not only the reactor itself but blowers, heat-exchangers, etc. The simulator will be able to reproduce abnormal working conditions, a facility which will be under the control of an instructor provided with a special panel out of sight of the trainee. The simulator is to be installed at Berkeley towards the middle of 1959.

* * *

The ninth annual report of **The Gas Council,** covering the year ended March 31st, 1958, shows that the industry had a net surplus of £2,820,610 on a gross income of £388,600,000. Capital expenditure during the year totalled £55,700,000. The industry has continued to concentrate production in the larger and more economic works, and seventy-five smaller works were closed during the year. There are now only 536 manufacturing establishments, compared with 1,050 at vesting date (May 1st, 1949), although capacity has increased by 23 per cent. Important progress is reported in the development of new processes and sources for the supply of gas, including the use of poorer quality small coal; gas from oil refineries and coal mines ("fire-damp"); and the importation of gas in liquefied form from overseas. Sir Harold Smith, chairman, The Gas Council, supplementing the report at a Press conference, expressed disappointment at the results of the search for natural gas in Britain. One well was working in Scotland, but the only other deposits found had been small. "We seem to be the only country in the world," said Sir Harold, "where natural gas is not found in quantity."

In a recent issue of this journal we made reference to the £30-million contract awarded jointly to British Thomson-Houston Export Co. Ltd. and International Combustion Ltd., for plant for the new 600-MW Buenos Aires power station, being built for Agua y Energia Electrica (E.N.D.E.). The five 120-MW reheat boilers being supplied by International Combustion (Export) Ltd. for the station will be equipped with air-heaters and draught plant made and supplied by **James Howden & Co. Ltd.** Associated with each boiler will be two air-preheaters with a total heating surface of 292,000 sq. ft.; two forced-draught fans to handle 356,000 cu. ft./min. of air; two induced-draught fans to handle 458,000 cu. ft./min. of gas; and two gas recirculating fans to handle 58,000 cu. ft./min. of gas.

* * *

The **Central Electricity Generating Board** has applied to the Minister of Power and Local Planning Authority, for consent to establish a third coal-fired power station at Drakelow, near Burton-upon-Trent. To be known as Drakelow "C," it will have an installed plant capacity of about 1,500 MW making it the largest power station yet planned in this country. The exact sizes of generating sets and boilers to be installed have yet to be decided. The Drakelow site is on the fringe of the East Midlands coalfield, which is a major source of low-grade coals used in the generation of electricity. The 240-MW Drakelow "A" station was commissioned in 1954, and the first set in the 480-MW "B" station is due to come into operation before the end of this year.

* * *

Sigmund Pumps Limited announce that **Mr. H. P. Lord,** A.F.C., B.Sc., the present general sales manager has been appointed as a director of the company.

* * *

We have received from **Wallace & Tiernan Ltd.,** Power Road, London, W.4, two new publications. The first of these deals with the company's dry chemical feeder, which operates on the volumetric principle, and will feed free-flowing chemicals in dry powder or granular form, with controlled accuracy. Arching, clogging or flooding of the material is prevented by the design of the feeder and hopper mechanism. The second publication describes the company's Merchen scale feeder, which is available to feed diverse types of dry, ground and free-flowing materials by weight in a constant delivery. The totally-enclosed construction of this unit makes it suitable for handling dangerous or easily contaminated commodities.

NOTES *Personal* AND *Industrial*

The following staff changes at the Atomic Energy Research Establishment, Harwell, are announced by the United Kingdom Atomic Energy Authority. **Dr. J. V. Dunworth,** formerly head of the reactor division, has been appointed assistant director (Reactor Research Policy). In this post he will be special adviser to the director of Harwell. He is succeeded as head of the reactor division by **Mr. T. M. Fry,** who has been a deputy-head of the reactor division. **Dr. Peter Thonemann,** head of the Controlled Thermonuclear Reaction (Fusion) Division at Harwell, has been granted study leave for one year from March, 1959. He will be going to the Institute of Advanced Studies in the University of Princeton, where he will work on plasma physics. In Dr. Thonemann's absence, the Harwell fusion programme will be carried forward by his deputy, **Mr. R. S. Pease,** under the supervision of Mr. D. W. Fry, who is deputy-director of Harwell, with special responsibility for this work.

* * *

Dr. D. T. A. Townend, C.B.E., director-general of the British Coal Utilisation Research Association, and past president of the Institute of Fuel, was the first British recipient of the gold medal of the Institut Francais des Combustibles et de l'Energie, at a ceremony held in Paris on October 21st. The medal, which is designed to recognise outstanding scientific achievement in the field of utilisation of fuel and power, was presented by M. Ramonet, Minister of Industry and Trade, and the citation upon Dr. Townend's achievements was delivered by M. Cheradame, technical director-general of the Centre d'Etubes at Recherches des Charbonnages de France.

* * *

Mr. A. W. A. Dick-Cleland, B.Sc., A.R.T.C., M.I.E.E., F.B.I.M., who recently relinquished his appointment as joint managing-director of Lancashire Dynamo and Crypto Limited, Trafford Park, Manchester, has been appointed a director of Brush Electrical Engineering Co. Ltd., and the manager of their rotating machines division at Loughborough.

* * *

Mr. W. M. Tulip, B.Sc., M.I.Mech.E., has been appointed regional secretary of the North Eastern and Yorkshire Region of the Central Electricity Generating Board. From 1936 to 1946, Mr. Tulip was assistant engineer on the personal staff of the general manager of the North Eastern Electric Supply Co., and then became technical assistant to the general manager. On March 1st, 1948, he was appointed divisional secretary of the North Eastern Division of the then British Electricity Authority, the post he now relinquishes.

Mr. J. W. Plowman (Dewrance & Co. Ltd.) has been re-elected chairman of the British Valve Manufacturers' Association. **Mr. N. P. Newman** (Newman, Hender & Co. Ltd.) has been re-elected vice-chairman.

* * *

Mr. H. N. Wigan has resigned from the board of the Amber Chemical Company Limited. **Mr. J. Firminger,** who joined the company at the end of 1957, and was appointed general manager (home sales), is now appointed technical manager.

* * *

Dr. H. M. Finniston, who was until recently head of the metallurgy division at the research establishment of the United Kingdom Atomic Energy Authority at Harwell, has been appointed research manager of the Nuclear Research Centre in Newcastle, of C. A. Parsons & Co. Ltd., who, as a member company of the Nuclear Power Plant Co. Ltd., are responsible for all nuclear and other research work relating to reactors, within the organisation.

* * *

Rhodes, Brydon & Yauatt Ltd., Stockport, manufacturers of centrifugal pumps under the trade mark "Mopump," announce that **Mr. D. C. McCulloch,** of Newcastle upon Tyne, who has represented the company as sole agent for the past 22 years, retired at the end of October. **Mr. M. J. B. Hodgson,** B.Sc., has been appointed area manager of the newly-established Northern Counties office at 60, Highbury, Jesmond, Newcastle upon Tyne, 2.

* * *

Major-General E. P. Readman and **Miss V. A. Pease** have joined the Board of Amber Chemical Industries Limited. Major-General Readman retired recently from the position of managing director of the English Steel Tool Corporation. Miss Pease has been for some time past a director of the Amber Chemical Company Limited, and Charles H. Windschuegl Ltd., component companies, of the Amber Group.

* * *

Recent engineering and commercial appointments announced by Metropolitan-Vickers Electrical Co. Ltd., include those of **Mr. C. F. Saunders,** Assoc. M.C.T., A.M.I.E.E., M.Inst.W., formerly chief engineer, heating and welding department, as chief engineer, standards department; **Mr. G. H. Moule,** formerly assistant chief engineer (heating), heating and welding department, as chief engineer, heating and welding department; **Mr. R. F. Mansfield,** A.M.I.E.E., as assistant sales manager, industrial control department; and **Mr. F. Crowther,** Assoc. M.C.T., A.M.I.E.E., A.M.A.-M.E.M.E., as assistant chief engineer (design), industrial control department.

Mr. Arthur Griffiths, O.B.E., M.I.P.E., has been appointed as group managing director of Sterling Industries Limited, Chard, Somerset. Mr. Griffiths has been a director, and general manager of the Daimler Company Limited, Coventry, since 1956. Prior to this he was director and general manager of F. Perkins Ltd., Peterborough, from 1948 to 1956, and previously held senior positions in the Ford Motor Co. for 17 years. Sterling Industries Limited control Dualloys Limited, Sintered Metal Components Limited, the Sterling Instrument Company Limited, all of Chard, and Exactor Limited, of Edgware, Middlesex.

* * *

It is with regret that we record the recent death at the age of 55, of **Mr. J. F. Field,** former divisional controller of the South-East Scotland Division of the British Electricity Authority. After the division was taken over by the South of Scotland Electricity Board in 1955, Mr. Field transferred to the headquarters in London of the C.E.G.B. engineering department, where, under the chief engineer, he was engaged upon special duties connected with the development of plant and equipment, to operate on the Field cycle.

* * *

Bottogas Ltd., supplier of liquefied petroleum gases, is changing its name to **Shell-Mex and B.P. Gases Ltd.** The registered office will continue to be at Cecil Chambers, 76-86 Strand, London, W.C.2. The new name reflects the closer integration which is taking place with the parent Group, Shell-Mex and B.P. Ltd. Products will continue to be marketed under the brand name "Bottogas." The gases propane and butane, supplied by the company, are being used increasingly in industry for, among other purposes, firing metallurgical furnaces, the production of protective atmospheres for gas carburising and carbo-nitriding processes, bright annealing, and the enrichment of producer gas.

* * *

Both **Associated Electrical Industries Ltd.** and **A.E.I.-John Thompson Nuclear Energy Co. Ltd.** have moved from Crown House, Aldwych, W.C.2, to 33, Grosvenor Place, London, S.W.1. (Telephone: Belgravia 7011.)

* * *

The Magnetic Valve Company Limited and **Heather Filters Limited,** have changed their address to 7, Kendall Place, Baker Street, London, W.1. Telephone: Hunter 1801.

* * *

Prat-Daniel (Stanmore) Ltd. announce that the name of the company has been changed to **Prat-Daniels (Stroud) Ltd.** The address is Whitecroft, Nailsworth, Glos. Tel.: Nailsworth 446/7.

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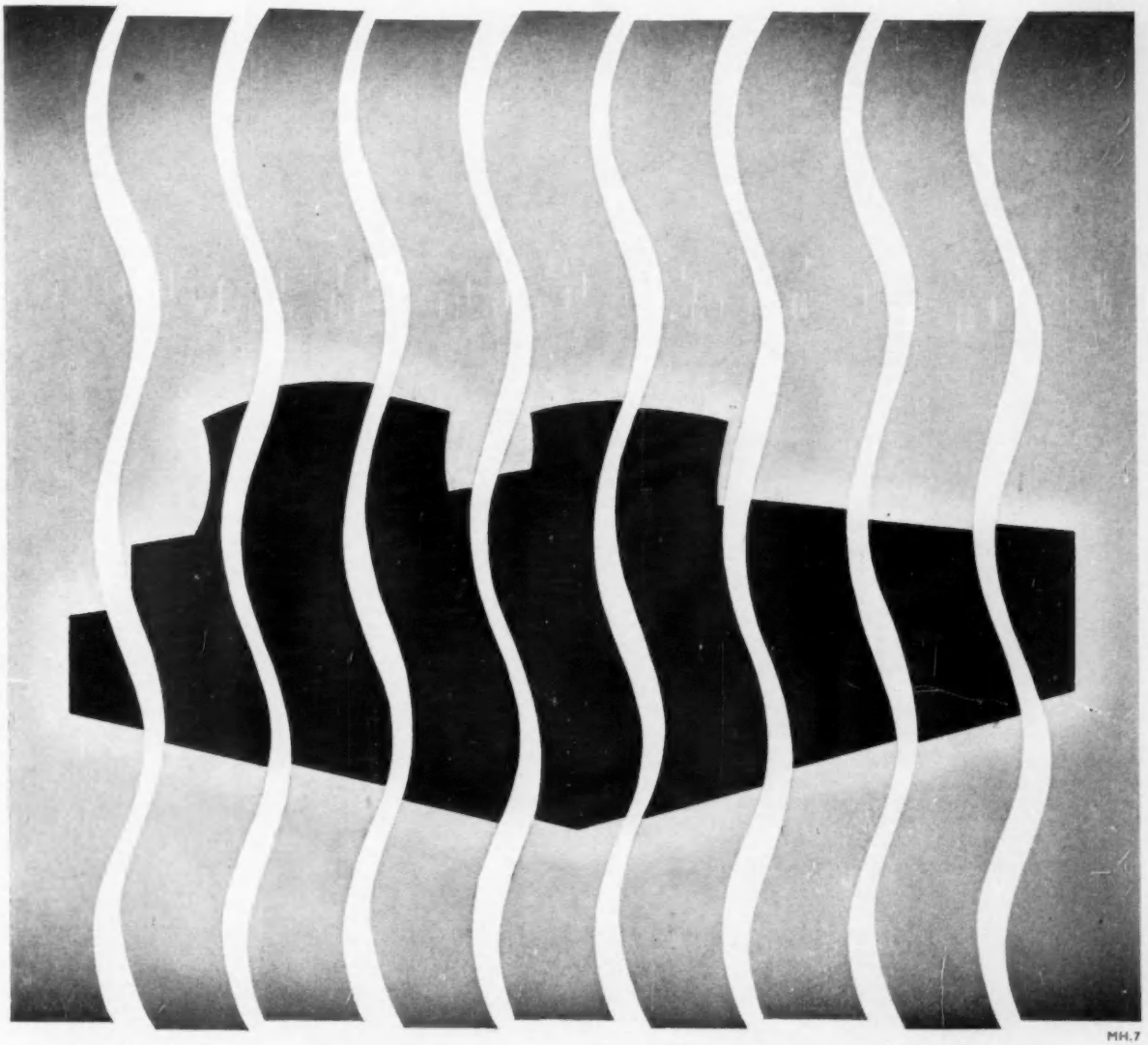

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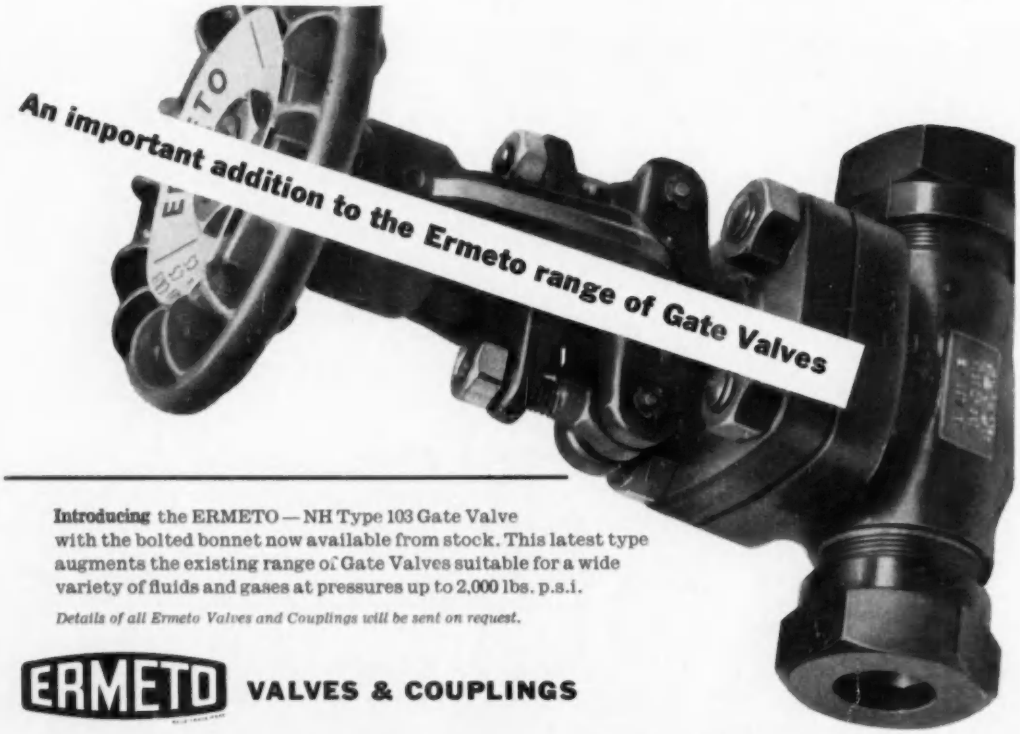

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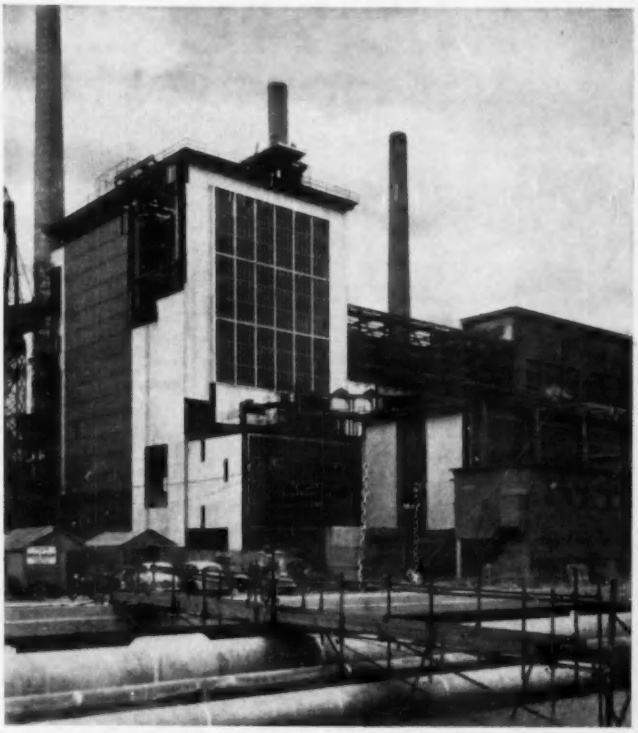

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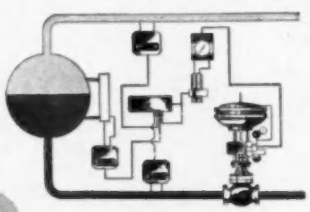
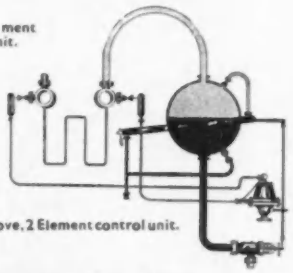


Left, 3 Element control unit.



Above, 2 Element control unit.

Write for literature or ask for an Engineer to call.

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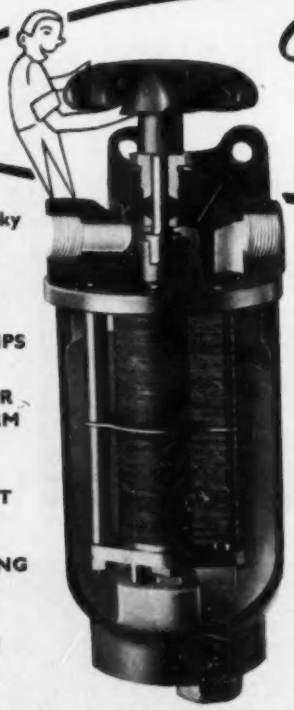

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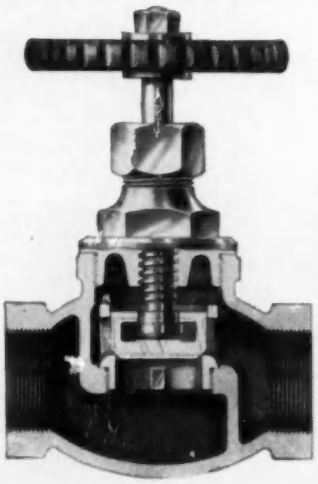

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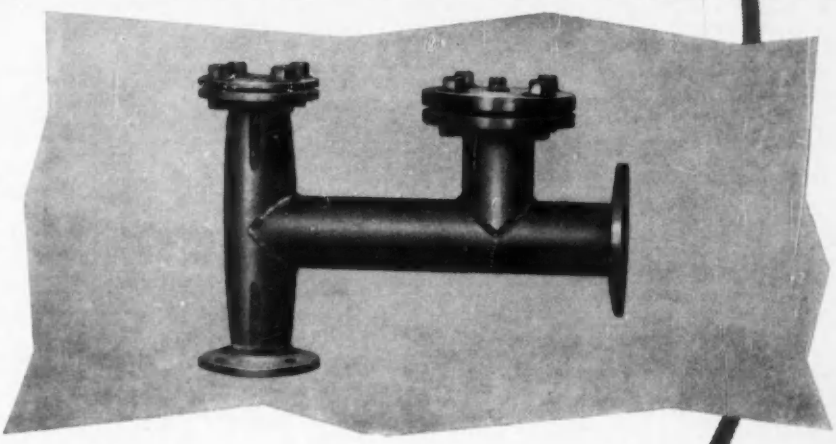

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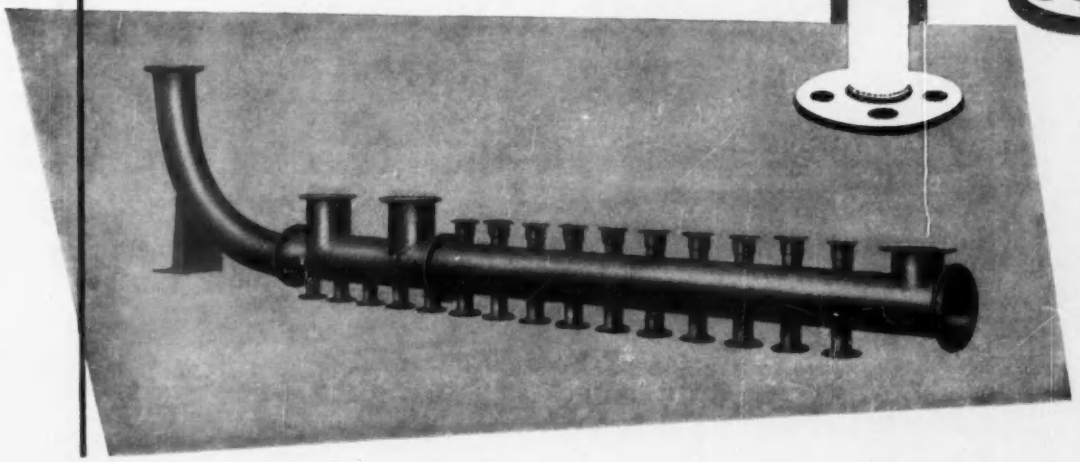

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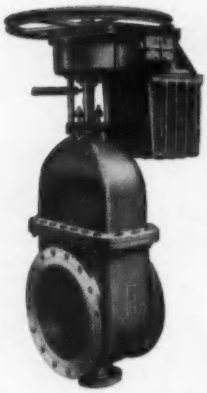

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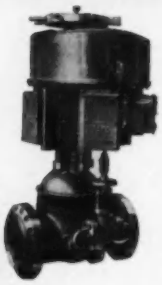

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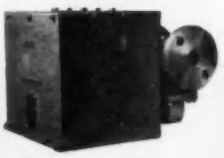

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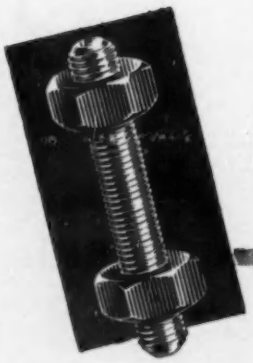

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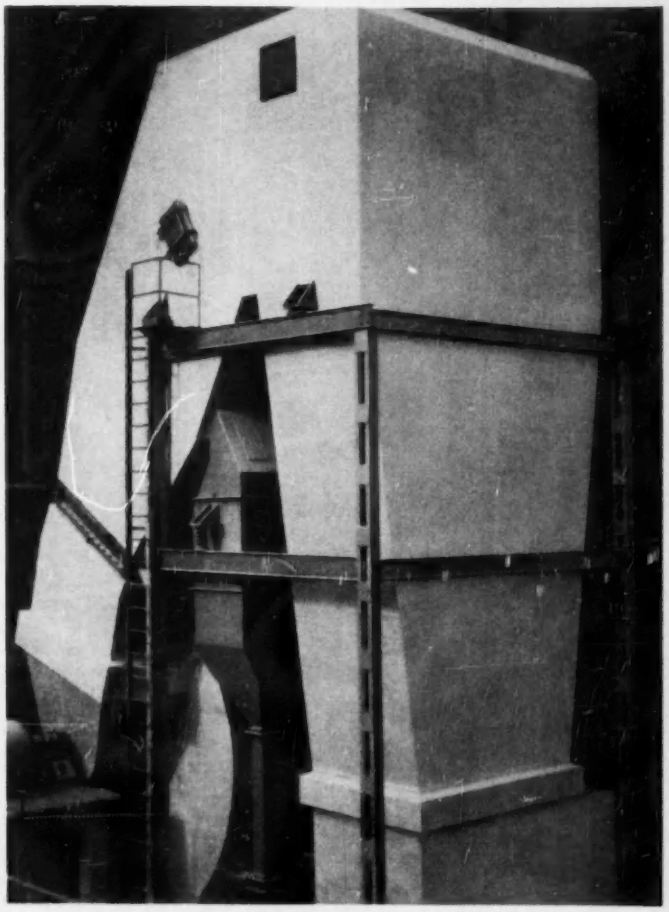
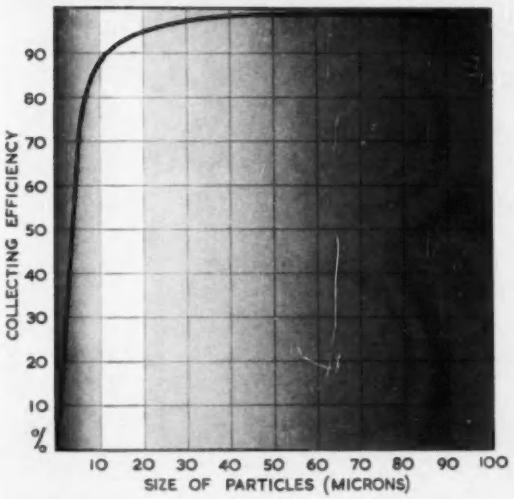
A Holmes-Rothemuhle Collector installation cleaning flue gases from boilers used for space heating purposes. Capacity: 100,000 *c. f. m.*





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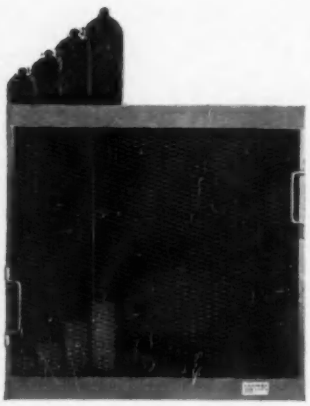

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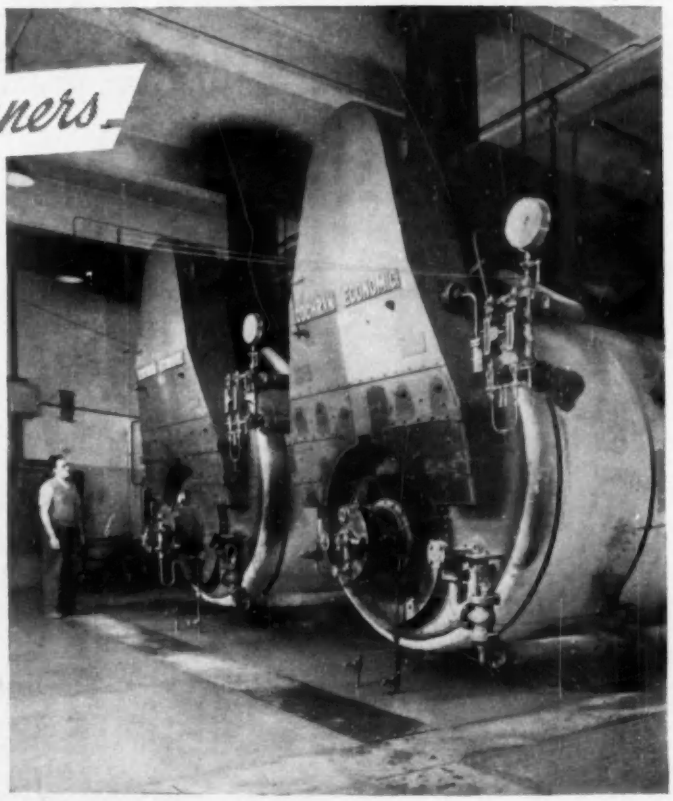

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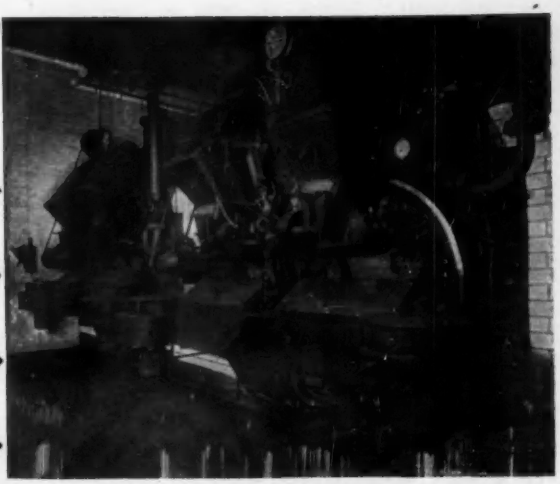

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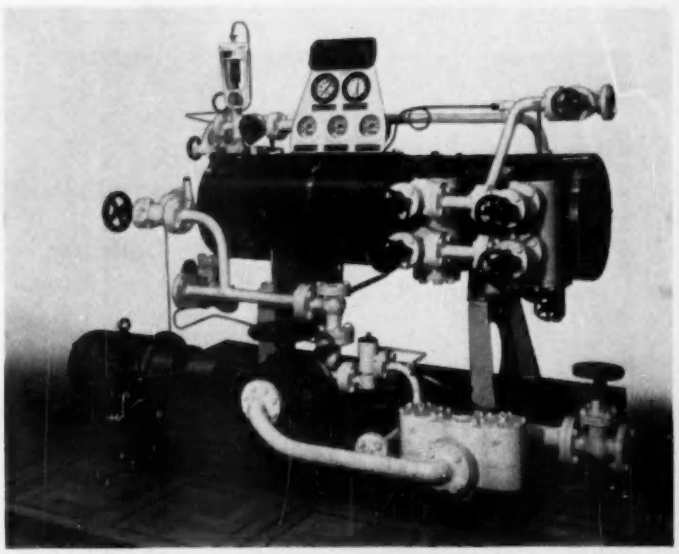

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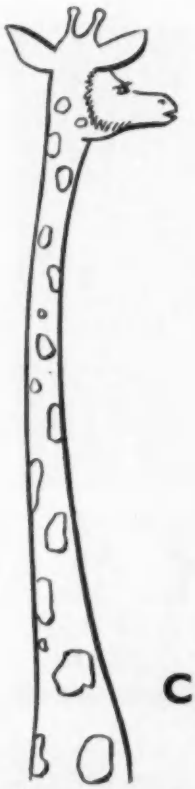

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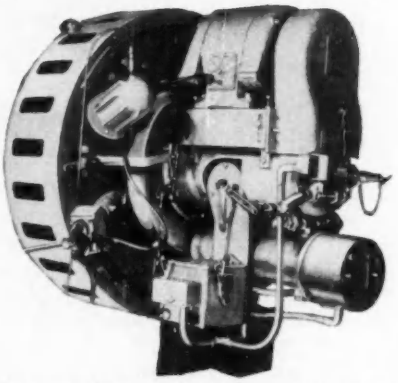

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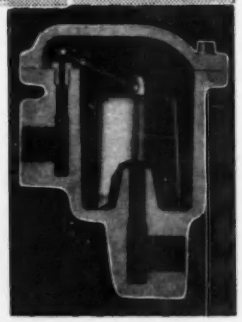

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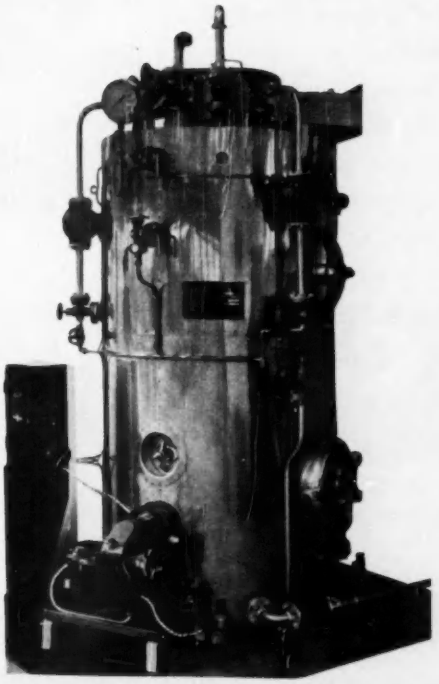

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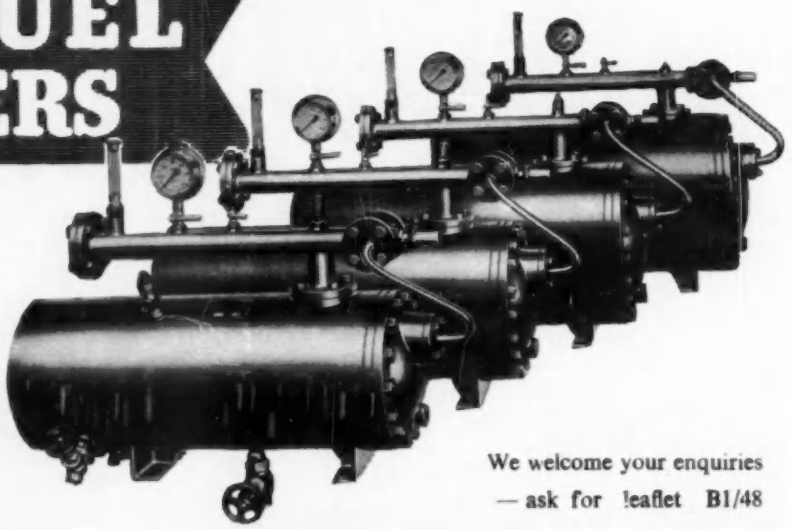

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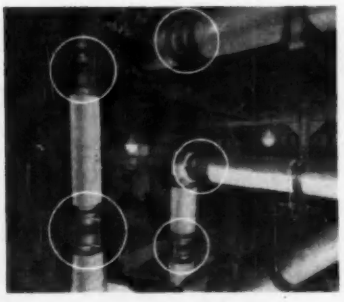

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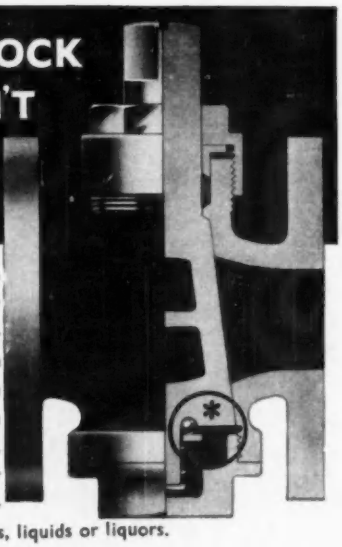

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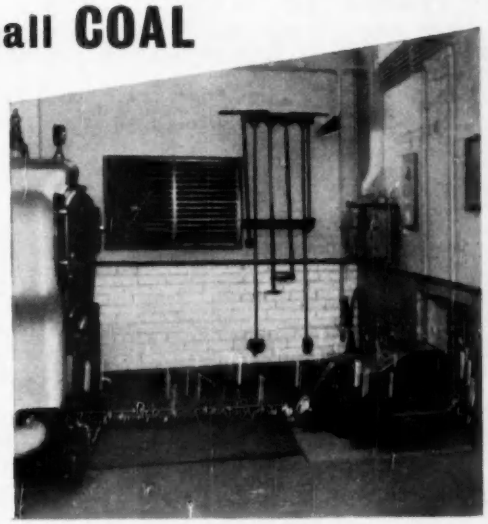

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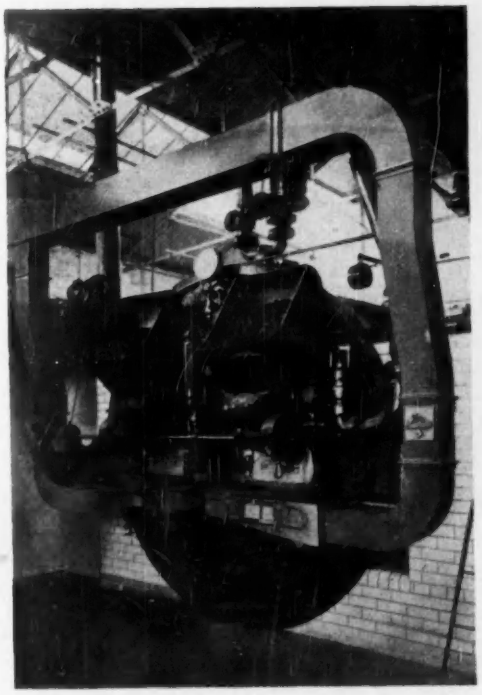

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Index to Advertisers

	Page
Atlas Preservative Co. Ltd.	xi
Automotive Products Co. Ltd.	ii
Babcock & Wilcox Ltd.	lviii
Bouellat Eng. Co. Ltd.	liii
British Ermeto Corporation Ltd.	lx
British Industrial Eng. Co. (Staffs.) Ltd.	xlix
British Paints Ltd.	xxxviii
British Thomson-Houston Co. Ltd.	lii
British Vacuum Cleaner & Eng. Co. Ltd.	liv
Caird & Rayner Ltd.	lxxii
Cape Asbestos Co. Ltd.	xlvi, xxxiv
Chemical & Insulating Co. Ltd.	lix
Clarke, Chapman Ltd.	xlii
Classified Advertisements	lxxvi
Clyde Fuel Systems Ltd.	lxx
Cockerill-Ougree	ix
Copes Regulators Ltd.	lxii
Cory, Wm., & Sons Ltd.	xxviii
Cradley Boiler Co. Ltd.	xxiii
Crane Ltd.	xxiv
Danfoss Manufacturing Company	*Back Cover*
Danks, Edwin, & Co. Ltd.	xx
Defur Descaling Services Ltd.	lxxiii
Dewrance & Co. Ltd.	—
Electroflo Meters Co. Ltd.	*Cover i*
Fibreglass Ltd.	xliv
Fluidrive Eng. Co. Ltd.	xvii
Foster Transformers Ltd.	lxiv
Fraser & Fraser Ltd.	xviii
General Refractories Ltd.	xl
Glenboig Union Fireclay Co. Ltd.	xxvi
Green, E., & Son Ltd.	xxix
Greenwich Insulation Co. Ltd.	lxxiii
Harcourt, David, Ltd.	lxxiv
Hargreaves Ltd.	lv
Hayward Tyler Ltd.	xxxv
Heather Filters Ltd.	lxviii
Hick Hargreaves & Co. Ltd.	xxv
Hodgkinson, James, (Salford) Ltd.	xxi
Holmes, W. C., & Co. Ltd.	lxvii
Hopkinsons Ltd.	xliii
Hunt & Mitton Ltd.	lxiv
International Combustion Ltd.	xv
Jones, Tate & Co. Ltd.	lxvi
Judd Budd Ltd.	xviii
Lafarge Aluminous Cement Co. Ltd.	iv, xxii
Laidlaw, Drew & Co. Ltd.	lxviii
La Mont Steam Generator Ltd.	x
Lancashire Dynamo & Crypto Ltd.	xlvii
Lancaster & Tonge Ltd.	lxx
Lock, A. M., & Co. Ltd.	lx
Magnetic Valve Co. Ltd.	viii
Marshall Sons & Co. Ltd.	xlviii
Midland Heating & Ventilation Co. Ltd.	lvi
Midland Industries Ltd.	lxxvi
Morgan Refractories Ltd.	l
Newalls Insulation Co. Ltd.	lxi
Newton Chambers & Co. Ltd.	xix
Parsons, C. A., & Co. Ltd.	xlv
Permutit Co. Ltd.	iii
Prior Stokers Ltd.	lxxv
Proctor, J., Ltd.	lxix
Reavell & Co. Ltd.	lxxii
Ruston & Hornsby Ltd.	xxxvii
Shandon Scientific Co. Ltd.	lxxi
Shaw, Son & Greenhalgh Ltd.	xxxix
Simon-Carves Ltd.	xii
Slip Group of Companies	xxxii
Smith Bros. & Co. (Hyson) Ltd.	lxx
Solignum Ltd.	xiv
Spencer-Bonecourt-Clarkson Ltd.	li
Spirax-Sarco Ltd.	xxxi
Sulzer Bros. (London) Ltd.	xxxiii
Sunrod Ltd.	lxxi
Superheater Co. Ltd.	lxxvii
Teddington Aircraft Controls Ltd.	lxxiv
Thermix Industries Ltd.	xxx
Thompson, J., Wolverhampton, Ltd.	xiii
Thornycroft, John I., Co. Ltd.	lxix
Turbine Furnace Co. Ltd.	lxxv
United States Metallic Packing Co. Ltd.	lxxiv
Vokes Genspring Ltd.	xli
Wallsend Slipway & Eng. Co. Ltd.	vii
Walworth Ltd.	xvi
Ward, Thos. W., Ltd.	lxv
Whiffen & Sons Ltd.	lxiii
Wickstead, C., & Co. Ltd.	xxxvi
Willcox, W. H., & Co. Ltd.	xxvii
Winn, Martin, W., Ltd.	lxvi
Worthington-Simpson Ltd.	v
Yarrow & Co. Ltd.	vi
Zwicky Ltd.	lxii

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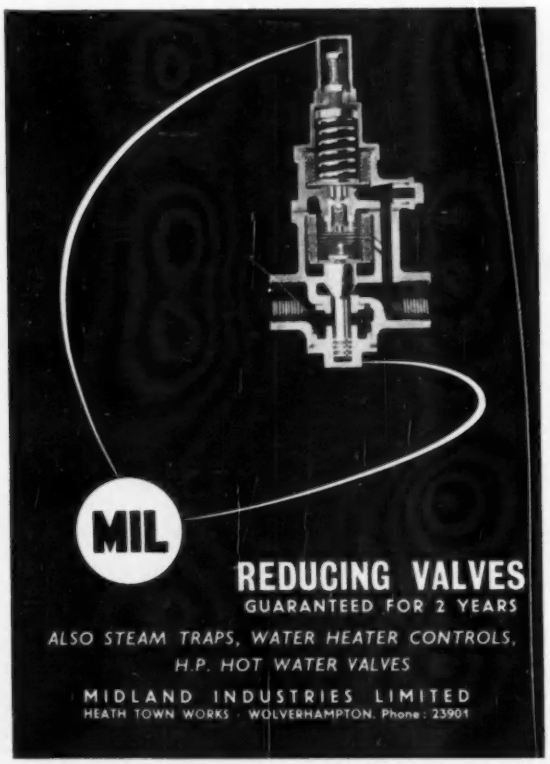

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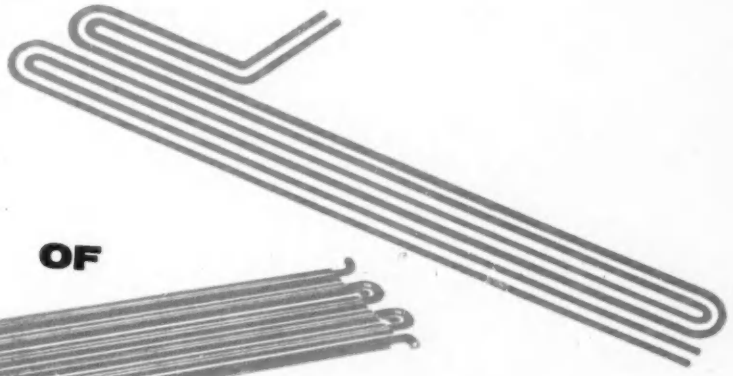

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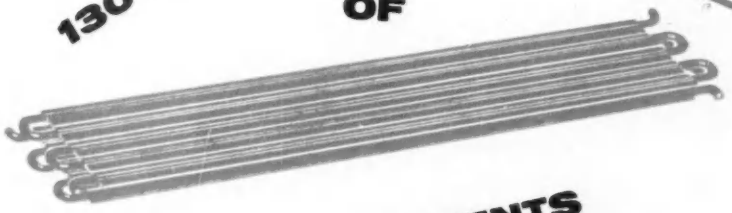

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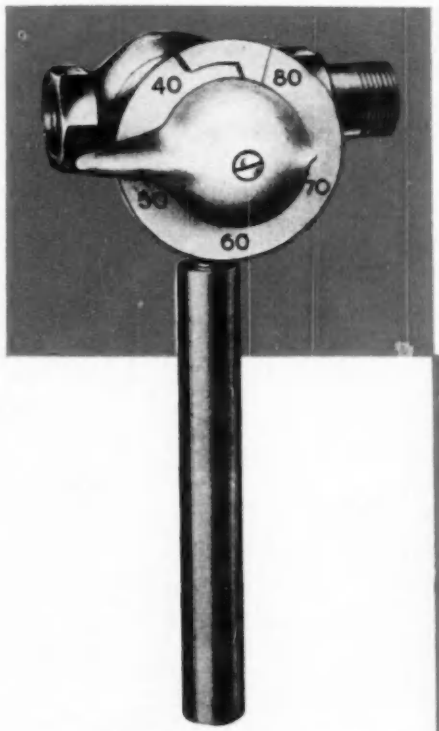

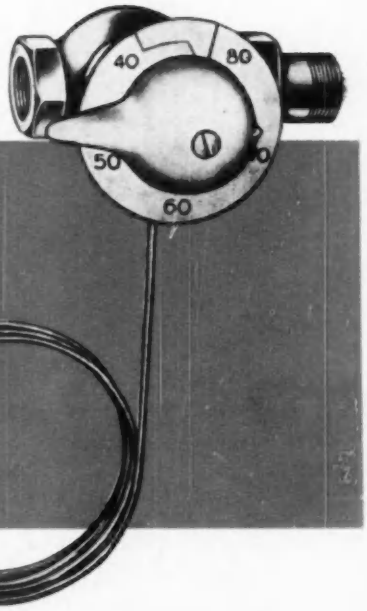

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